Proceedings WAMIP-2010
M. S. Rao, et al. (eds)
N.I.H., 2010

III-5

Management of Irrigation Water through Tensiometer in Paddy - A Case Study in the Kapurthala District of Punjab

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Abstract : Water resources of a Punjab consist of both the surface water and the ground water resources. The per capita water availability of India is decreasing due to ever increasing population Agriculture utilizes nearly 80% of available water resources in Punjab. During the last few decades there has been a spectacular development in agriculture in Punjab due to Green Revolution, which enables Punjab to contribute largely in Nation's food grain production. The state has developed its water resources by laying irrigation canals and we remove much more than we have. Facts states that per year we required 43 lakh ha-m of water to grow our crops in Punjab but what we have in our pocket is 30 lakh ha-m. Thus, we draw13 lakh ha-m of excess water from the ground which is a matter of great concern and attention. In this connection, PAU has launched a new technology by which farmers provide water to their paddy fields only when it required and our study from the last five years concluded that we can save upto 33% of water without having any adverse effect on our paddy yield.

Key words: Water, Punjab, Tensiometer, Grain yield, PAU

INTRODUCTION

The life of mankind and almost all the flora and fauna on the earth depends on the availability of fresh water resources. Water is used by every one every day. Of the earth's total water volume of about 1400 Mkm^3, about 97% is saline ocean water that is unsuitable for human as well as for plant use. (Bhatt 2010). The three major users of the water are domestic water supply, industry including power generation and agriculture. About $2/3^{rd}$ of water withdrawn world-wide from rivers and ground water is used for irrigated agriculture. Punjab is one of the smallest states of India with Total Geographical area of 5.036 million hectare which constitutes only 0.33% of world's land and 1.6% of India's total land During the last few decades there has been a spectacular development in agriculture in Punjab and we contribute around 42, 55 and 24% of rice, wheat and cotton respectively in the central pool (Source: statistical Abstract, Punjab. 2005). Nearly 80% of the water resources of Punjab are used by agriculture sector as cropped area is 86% with about 189% cropping intensity. In total irrigated land 27% is irrigated through canals and remaining 72% is irrigated through tube wells. Green Revolution has changed the overall scenario of Agriculture in Punjab and a mesh of irrigation canals has been laid all over. Most of the existing canal irrigation systems in Punjab are located in south-western districts such as Bathinda, Ferozepur, Mansa, Faridkot, Muktsar, etc. The number of tube wells has increased to 11.68 lakhs in 2004-2005 from 1.28 lakhs in 1970-71. This development resulted in water table increase in south-western districts causing water-logging and salinity problems and its decline in central districts. It is clear that almost 100 % of irrigated area in central districts is irrigated by groundwater. In the south-western districts the use of canal water is more than the ground water. During the last decade the average fall of water table in the central Punjab was o.55m/year (Hira et. al 2004). At some places the ground water level declined at the rate of even 0.75 to 1m/year. Facts

states that per year we required 43 lakh ha-m of water to grow our crops in Punjab but what we have in our pocket is 30 lakh ha-m. Thus, we draw13 lakh ha-m of excess water from the ground which is a matter of great concern and attention. In this regard irrigation scheduling is a must for the effective and judicious use of irrigation water.

Irrigation scheduling is a process to determine when to irrigate and how much water to apply. Researchers have employed demand based (meteorological) and supply based (soil water content) approaches for scheduling irrigation to field crops. Prihar et al. (1974) suggested a simple meteorological approach to schedule irrigation to crops based on the ratio between fixed depth (75mm) of irrigation water and net cumulative pan evaporation since previous irrigation. In Rice it has been demonstrated that higher yields can be maintained by irrigating crop at 2 days drainage interval after soaking in of previous irrigation (after 2 week of continuous ponding following transplanting). This helps in saving eight irrigations to rice (Sandhu et al. 1980). Hira et al. 2002 used soil water tension as a criterion for scheduling irrigation to rice and reported higher water use efficiency with irrigations at soil water tension value of 1600+_200mm.

In this regard, Punjab agricultural University is working from the decades to find out solution in this regard to maintain and uplift the underground water table. Some of the pioneer technologies are under ground pipelines, mulching, laser levelling, Tensiometer etc.

Tensiometer is a new technology which helps the farmers in irrigation scheduling. A tensiometer measures soil moisture. It is an instrument designed to measure the tension or suction that plants' roots must exert to extract water from the soil. This tension is a direct measure of the availability of water to a plant.

Fig 1: Tensiometer installed for irrigation scheduling

Tensiometers are most useful when a crop's water requirements are high and when any stress due to water shortage is likely to damage crop potential.

STUDY AREA

Kapurthala (A formerly princely state) is one of the smallest districts of Punjab both in terms of area and population. The district is divided into two non–continuous parts viz. Phagwara block in one part and the remaining four blocks in the other part. The agro-climatic conditions of the district Kapurthala coincide with the Central Punjab with smooth-plain topography. Krishi

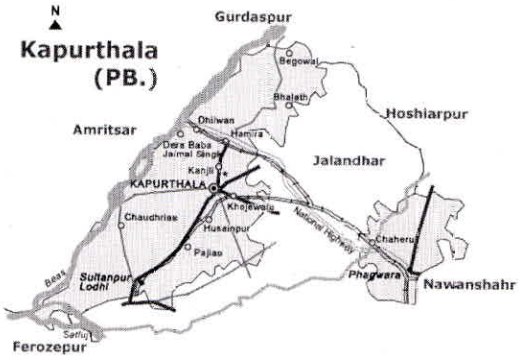

Fig 2: Sketch depicting the Location of Kapurthala district

Vigyan Kendra, Kapurthala is established on April 1991 and is located at 31°36' North and 75°37' East on the sultanpur road at an attitude of 221 meters. The water table is declining at an alarming rate in our district due to the intensive cropping pattern of paddy-wheat.

MATERIAL AND METHODS

Keeping the declining water table at the alarming rate, we carried out 18 demonstrations in the last five years to encourage the farmers to schedule irrigation through tensiometers. In this move, we divide the entire experimental plot in two equal parts and irrigate one half using farmer's indigenious technology and in other using tensiometer. The brief information about the Tensiometer that what is a tensiometer is mentioned as under.

PARTS OF TENSIOMETER

Reservoir and cork: It consists of two acrylic transparent tubes of specific dimensions. The inner tube is fitted with the narrow mouth of a ceramic cup of diameter equivalent to that of the outer tube. The upper end of the outer tube is fitted with a silicon cork. The cork on the reservoir must provide an airtight seal for the tensiometer. The body tube works as a reservoir, and the cork directly seals the system.

Ceramic cups: The ceramic cup is porous, but the openings are so small that when saturated with water, air cannot pass through within the range of soil water tensions to be measured. Water moving out through the porous cup causes the reading to change indicating the suction, or tension, at which the water is being pulled by the surrounding soil. Both the tubes and the ceramic cup are filled with distilled de aerated water. Before filing the whole tensiometer with water the cup is saturated overnight with water.

Coloured Strips: The upper portion of the outer tube is marked with three colored strips which coincide with the different levels of soil matric potential, based on the water level inside the inner tube. The irrigation to rice crop is recommended when the water level inside the inner tube just crosses the green strip and enters the yellow strip.

PRINCIPLE OF THE TENSIOMETER

The water in the inner tube of the tensiometer equilibrates with the surrounding soil through the ceramic cup and its level indicates the soil matric tension and hence the water status of the soil. The colored strips guide the farmers for scheduling irrigation to rice crop. When buried in the soil the ceramic cup of the tensiometer allows water to move freely in or out of the tube. As the soil dries out, water is sucked out through the porous ceramic cup, creating a partial vacuum inside the tensiometer which causes the water to move down. Soil tension increases as the soil dries out, the vacuum increases in the tensiometer and the water level falls down. When the soil is wetted by sufficient rainfall or irrigation, water flows back into the tensiometer, the vacuum decreases and the water level starts rising. Tensiometer measure how tightly water is held to the soil particles and not how much water is left in the soil. A sandy soil will reach a high tension sooner than a clay loam because sandy soils cannot supply as much water to the plant and it is used up more quickly. Tensiometers do not operate in dry soil because the pores in the ceramic tip drain and air is sucked in through them breaking the vacuum seal between the soil and the gauge on top of the tensiometer.

INSTALLATION OF TENSIOMETER

The number of tensiometer installation sites required will depend on the crops grown and field conditions. Fewer sites of tensiometers are needed when a single crop is grown in large blocks of uniform soil. If the soils are varied or different crops are to be grown, more sites are necessary. Tensiometers placed at about the mid-point of the main fibrous root system are used to determine when to irrigate. This is particularly important

during the period when the water requirement of the crop is highest and yields are most sensitive to water shortage. During this period tensiometers should be read daily

RESULTS

The experiments was carried at 18 locations during the five years in order to aware the farmers at the farmer's field and the precise results were discussed as under

Treatments

Mainly there were two treatments as under:

T_1 = Irrigation with Tensiometer.

T_2 = Irrigation as practiced by the farmers.

Plot Size

Generally we laid out our experiment in one acre of land and then divide in two plots of 4 Kanals. In one plot we irrigate by using tensiometer and in other we allowed the farmers to use his indigenous knowledge for irrigating his plots. Crop yield was not decreased in fact water saved to significant level.

Table 1: Water used to produce one kg of rice and total cost of water used to produce it Here in this table we tried to calculate the total water used to produce one Kg of Paddy and it's value in the market and only then we can have an idea of saving water by using Tensiometer.

Table 2: Detailed results of irrigation scheduling with Tensiometer in Paddy.

DISCUSSION

Tensiometer is an effective device which works on the principle of soil-water tension and guides the farmer as and when to irrigate his paddy field. Results revealed that use of Tensiometer saved from 11.1 to 30.7% of irrigations as compared to the farmers practice without having any adverse effect on crop yield. Table clearly depicts that during the year 2006 the water saved varies from 29.6 to 30.7 with almost similar yields. However, the water saving in terms of

Table 1: Water used to produce one kg of rice and total cost of water used to produce it

1acre= 4000sq.m
1 Irrigation = 10 cm= .10m
25 irrigation = 250 cm = 2.50 m
$1m^3$ = 1000 litres
$10,000m^3$= 10,000,000 litres
3000 kg Paddy = 10,000,000litres of water
1kg = 3333 litres
1 litre bisleri water bottle costs= 10 Rs
Thus, 1 kg of paddy costs about 33330 Rs

Table 2: Detailed results of irrigation scheduling with Tensiometer in Paddy.

Sr No.	Name of the farmers and address	Variety	Date of transplanting	Date of harvesting	Yield (q/ha)		Input (irrigation)		Irrigations saved (%)
					T_1	T_2	T_1	T_2	
	Year 2006								
1.	Jageer Singh S/o Sohan Singh, Village Karal Nau baad	PAU-118	13/6/06	1/11/06	73.3	73.5	19	27	29.6
2.	Sarwan S/o Gurmail Singh, Village Boolpur	PAU-111	25/6/06	2/11/06	68.4	68.5	18	26	30.7
	Year 2007								
3.	Balwinder Singh S/o Sadhu Singh, Vill: Patti Navi Bakash	PAU-201	20.06.07	31.10.07	74.25	73.95	25	34	26.0
4.	Sarwan Singh S/o Gurmail Singh, Vill: Boolpur	PAU-201	26.06.07	03.11.07	74.75	74.60	24	32	25.0
5.	Sukhwinder Singh S/o Mohinder Singh, Vill: Blairkhanpur	PAU-201	20.06.07	30.10.07	74.40	74.25	24	33	27.2
	Year 2008								
6.	Sh. Sarwan Singh S/o Sh. Gurmail Singh, Vill: Boolpur	HKR-47	22-06-08	28-10-08	68.6	69.0	13	18	27.8
7.	Sh. Sandeeppal Singh S/o Sh. Bachan Singh, Vill: Talwandi Choudhrian	PR-114	22-06-08	25-10-08	69.5	69.1	12	16	25.0

8.	Sh. Sukhwinder Singh S/o Sh. Mohinder Singh, Vill: Blerkhanpur	PR-116	14-06-08	22-10-08	70.3	69.8	14	17	18.0
9.	Sh. Apinder Singh S/o Sh. Surinderjit Singh, Vill: Purana Thatta	PR-111	11-06-08	23-10-08	67.3	67.4	12	16	25.0
	Year 2009								
10.	Sh. Sarwan Singh S/o Sh. Gurmail Singh, Vill: Boolpur	Pusa 44	22-6-09	2-11-09	75.00	75.00	20	25	20.0
11.	Sh. Sandeeppal Singh S/o Sh. Bachan Singh, Vill: Boolpur	HKR127	28-6-09	27-10-09	65.6	65.5	19	23	17.4
12.	Sh. Sukhwinder Singh S/o Sh. Mohinder Singh, Vill: Blerkhanpur	HKR127	22-6-09	30-10-09	70.5	70.3	19	24	20.8
13.	Sh. Apinder Singh S/o Sh. Surinderjit Singh, Vill: Purana Thatha	Pusa 44	12-6-09	24-10-09	74.6	74.5	20	24	16.6
	Year 2010								
14.	Sh. Sarwan Singh S/o Sh. Gurmail Singh, Village Boolpur	HKR-47	22-6-10	14-10-10	64.5	65.0	13	16	18.8%
15.	Sh. Sukhwinder Singh S/o Sh. Mohinder Singh, Village Blerkhanpur	HKR-47	20-6-10	13-10-10	62.3	62.5	15	13	13.3%
16.	Sh. Gurjant Singh S/o Sh. Ajit Singh, Village Talwandi Choudhrian	HKR-127	20-6-10	15-10-10	64.3	65.5	15	12	20.0%
17.	Sh. Sukhjinder Singh S/o Sh. Tara Singh Village Mohablipur	HKR-127	19-6-10	16-10-10	69.5	70.0	18	16	11.1%
18.	Sh. Harjinder Singh S/o Sh. Gurdeep Singh, Village Kolianwal	HKR-45	22-6-10	16-10-10	66.8	66.3	14	11	21.4%

irrigation saved varies from 25.0 to 27.2, 18.0 to 27.8, 16.6 to 20.8 and 11.1 to 21.4 in consecutive 2007 to 2010 with a non-significant difference in the grain yield. Thus, farmers on one hand could save water worth thousands of rupees by using this Technique and on other hand save water for the future generations. Similar, trends were noticed by Hira et al (2007) by whom Tensiometer can save upto 20% of irrigation water without having an adverse effect on Paddy yield whereas Sidhu et al (2008) reported a saving of 25-30% of irrigation water without having an adverse effect on Paddy yield

CONCLUSION

The faulty cropping pattern along with faulty agricultural practices has created a hydrological imbalance in Punjab. The demand of water is increasing due to increasing population, while the water resources are being exploited mercilessly without thinking for the future. Strategies for the rational use of water through tensiometer have been discussed which are not difficult to adopt. Farmers can easily save upto 30% of irrigation water without having any adverse effect on the grain yield of paddy. Now the time has come when the scientists, researchers, extension workers and farmers should join hand to save irrigation water through tensiometer.

ACKNOWLEDGEMENT

The authors acknowledge the co-operation received by the farmers of Kapurthala district for successfully conduction of these trials on to their fields. The help received for the timely guidance by Dr. S.S Kukal is also acknowledged.

REFERENCES

Bhatt. R (2010) Water resource management for sustainable crop production in India. Agrobios. VIII: 15-17.

Hira GS, Singh R and Kukal SS (2002a) Soil matric suction: a criterion for scheduling irrigation to rice. Indian Journal of Agricultural Sciences 72:236-37.

Hira GS, Jalota SK and Arora VK (2004b) Efficient management of water resources for sustainable cropping in Punjab. Research Bulletin: Department of Soils, PAU, Ludhiana.

HiraG S, Sidhu A S and Kukal SS (2007c) Tensiometer Chone vich pani di bachat laye sadaran yanter. In Pani bachoa Punjab bachoa released from Punjab agricultural University, Ludhiana. 16-18.

Prihar SS, Gajri PR and Narang RS (1974) Scheduling irrigation to wheat using pan evaporation. Indian Journal of Agricultural Sciences 44:567-71.

Sidhu A S, Kukal SS and Hira GS (2008) P.A.U Tensiometer: Chone Nu Pani laun Di Lahevand technique (extension Bulletin) released from Punjab agricultural University, Ludhiana

Sandhu BS, Khera KL, Prihar SS and Singh B (1980) Irrigation needs and yield of rice on a sandy loam soil as affected by continuous and intermittent submergence. Indian Journal of Agricultural Sciences 50: 492-96.