Irrischeduler- a simple device for scheduling irrigations

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Abstract

Farmers do not use any instruments for scheduling irrigations and depend only on their visual judgment of crop and soil conditions. Evaluation of the farmers' decisions revealed 5 to 30 per cent variations from the appropriate soil moisture for scheduling irrigations. Understanding of the farmers' perceptions (through participatory rural appraisal, PRA in village Lakhan, Dist. Hapur, Uttar Pradesh) indicated the complexity of available instruments as the major cause of their non-adoption by farmers. A simple device, namely irrischeduler, was developed to indicate the time for irrigation based on the soil moisture level. The developed device does not require the user to read from a gauge, which was reported by farmers as cumbersome in their perception. Performance evaluation of the developed device indicated that it could be used for most type of soils, excepting sandy and highly clay soils.

1. Introduction

The dominant method of irrigation practiced in large parts of the country consists of diverting a stream from the head of a field into furrow or borders and allowing it to flow down the grade by gravity. Generally under these surface irrigation methods, the crop utilizes only less than one half of the water released. A good part of the applied water is lost in conveyance, application, runoff and evaporation. Accordingly the efficiency of surface irrigation methods is low. Higher irrigation efficiencies can be realized in the farmers fields if, as a first step, amount of water applied and the time of application of available water are fixed appropriately.

Soil in the plant root zone acts as a reservoir for water. Soil texture is the primary factor influencing the amount of water that the soil reservoir can store. Available water is defined as amount of water that plants are able to withdraw from the soil for their use. Fine textured soils, such as clays, silt loams, or loams are able to hold much more available water than sandy, coarse-textured soils. Soil water holding capacity is an important factor to consider in determining the appropriate timing and volume of irrigation water. Tensiometer is a device that indicates the level of soil moisture.

In exclusively canal irrigated areas there is hardly any scope for scheduling irrigation differently from the schedule of the operation of the canal itself. But even in situations where the water supply is in control of the farmers themselves, they depend only on their visual judgment of crop and soil condition for scheduling irrigations and do not use any instrument for the purpose.

Participatory Rural Appraisal was conducted in village Lakhan, Dist Hapur, Uttar Pradesh to investigate the farmers' perceptions for non-adoption of available tools like resistance block and tensiometers for monitoring soil moisture for scheduling of irrigations. Based on their responses existing tensiometer was modified and an irrischeduler was developed. The article presents the details of the developed device, namely irrischeduler, its calibration using a standard tensiometer and discusses its appropriateness in scheduling irrigations under different type of soils.

2. Materials And Methods

2.1 Participatory Rural Appraisal

A village namely Lakhan, District Hapur, Uttar Pradesh was selected to study the irrigation practices followed by the farmers. The village has some cultivated area exclusively under canal command, some cultivated area exclusively under tube well command and some having both, canal as well as tube well irrigation facilities. A detailed participatory rural appraisal (PRA) study conducted to understand farmers perceptions about irrigation scheduling revealed that none of the farmers adopted any tools for scheduling irrigations and depend solely on their visual judgement of crop and soil condition (Rajput and Patel[1]). On discussion with the concerned farmers and on demonstration of the use of tensiometers to them it was found that the farmers considered the reading of vacuum gauge cumbersome and wished to have a simpler device.

2.2 Evaluation of Farmers' Decisions of Irrigation Scheduling

Fifteen farmers having land holdings ranging from 0.15 ha to 5.6 ha were selected for observing their irrigation practices. Soil moisture contents at which the selected farmers actually applied the irrigations in wheat crop (2001-2002) were recorded and were compared with their respective appropriate soil moisture levels for studying the accuracy / inaccuracy in their judgment for scheduling irrigations without the use of any appropriate instruments.

Difference between the Field capacity and the wilting point of a soil is considered as the available irrigation water. The irrigation is scheduled on depletion of a fixed percentage (normally 50 per cent) of the available soil moisture. Soil moisture contents at field capacity and wilting point of the soils of the study area were determined. The soil moisture at the time of irrigation by different farmers were recorded and compared with their respective appropriate soil moistures for irrigation.

2.3 Scheduling Irrigations Using Tensiometers

Tensiometers are one of many tools available for irrigation management. With practice, tensiometers can provide the information required to make proper irrigation decisions (Goldhamer and Synder[2]). A tensiometer consists of a porous cup, connected through a rigid body tube to a vacuum gauge, with all components filled with water. The porous cup is normally constructed of ceramic because of its structural strength as well as permeability to water flow (Michael[3]).

Tensiometers are placed in the field with the ceramic cup firmly in contact with the soil in the plant root zone. The ceramic cup is porous so that water can move through it to equilibrate with the soil water. A partial vacuum is created as water moves from the sealed tensiometer tube. As the soil dries, water potential decreases (tension increases) and the tensiometer vacuum gauge reading increases. Conversely, an increase in soil water content (from irrigation or rainfall) decreases tension and lowers the vacuum gauge reading. In this way, a tensiometer continuously records fluctuations in soil water potential under field conditions (Pogue and Pooley[4]).

The range of operation of a tensiometer is generally limited between 10 and 85 cb. Waterlogged conditions are indicated when tensimeter reads below 10 cb and leaf defoliation begins when reading exceeds 85 cb (Peacock *et.al*[5]) . Above 85 cb the column of water in the plexiglass tube will form water vapor bubbles (cavitate), and the instrument will cease to function (Smajstrla and Harrison[6]).

A tensiometer is placed in the portion of the root zone that represent average depletion level of the entire root zone depth. The general depletion levels are 40, 30, 20 and 10 per cent of the water used by the crop from different quarters of the root zone (Michael *et.al*[7]). Consequently, a tensiometer needs to be placed between the second and third quarter of the root zone or at 63 percent of the depth of the roots in order for it to be placed in the depth of the root zone representing the average extraction level. For example if the root zone is 50 cm the tensiometer should be placed at 31.5 cm (Levin *et.al*[8]).

2.4 Development of an Irrischeduler

A regular tensiometer was modified to develop it in to an irrischeduler. In the irrischeduler a transparent tube (rigid Plexiglass) and a coloured float is used to indicate the level of water in it. The porous cup (ceramic) is used at one end of the tube and the tube is filled with water and is sealed from the other end with the help of a watertight cork. The ceramic cup is installed in the soil at an appropriate depth as discussed in case of tensiometers above. The irrischeduler provides an opportunity to monitor soil moisture fluctuations through change in water level in its tube. It may also enable marking one value on the tube indicating maximum permissible drop of water level to indicate the time for scheduling next irrigation. Characteristic curve of irrischeduler was developed and it was calibrated with the help of a slandered tensiometer. Figure 1 presents a tensiometer and an irrischeduler installed side by in a tomato field.

3. Results and Discussion

Fifteen farmers having land holdings from 0.15 ha to 5.6 ha were selected for studying the variations in farmers' judgment from their respective appropriate soil moistures for scheduling irrigations. Soil moisture contents at which the selected farmers actually applied their irrigations for wheat crop (2001-2002) were recorded and are presented in Table 1. Soils of the selected farmers fields were analyzed to determine their textures (Table 2). Appropriate soil moisture levels in respect of different farmers fields were determined using a hydraulic properties calculator (Saxton[9]) for scheduling irrigation and the same are presented in Table 2.

Table 1 indicates that the farmers having exclusively canal irrigation facility irrigated four times when the canal was in operation and they could have not scheduled their irrigations otherwise. The farmers having tube well irrigation facility did tend to irrigate more frequently than required and allowed much less soil moisture depletion than what was appropriate. Farmers having tubewell irrigation facility irrigated wheat fields 6 to 7 times (Table 3). It may also be noted from Table 3 that the farmers never allowed the soil moisture to deplete upto allowable level and irrigated at soil moistures 5 % to 30 % above the appropriate soil moisture level (Table 3).

Participatory rural appraisal was conducted in village Lakhan involving all the selected 15 farmers. Scoring and Ranking techniques of PRA indicated that farmers schedule irrigatios on the basis of crop condition (Rank I) followed only by soil condition (Rank II). No farmer used any instrument or device for the purpose. Demonstration of the use of a regular tensiometer received the comments from the farmersthat it was cumbersome as it required reading from a gauge. However, farmers wished to have a simpler device but without a gauge for trial in their fields themselves.

An irrischeduler was developed having a transparent plexiglass tube and a coloured plastic ball in it to indicate water level in it. The irrischeduler was installed in a tomato field. A regular tensiometer was also installed nearby (Figure 1). With each passing day water level in irrischeduler started falling tensiometer started showing increasing readings. The relationship between the fall of water level inside the irischeduler tube and the reading of the vacuum gauge of the tensiometer with decreasing soil moisture were developed (Figure 2).

Characteristic curve was developed for the irrischeduler relating the fall of water level inside the irrischeduler tube and the soil moisture level. Based on the estimated appropriate soil moisture for scheduling irrigation for a field (Table 2), its corresponding level of water level in irrischeduler was determined and marked on its body. The farmer then had to schedule next irrigation of his field when the water level in the irrischeduler fallsbelow that mark. On the day of irrigation, irrischeduler tube should be filled with water completely and sealed with its cork.

The values of field capacity and wilting point are a function of soil texture. The range of available soil moisture varies with soil type. Also different levels are allowed before scheduling next irrigation based mainly on the crop type. Figure 3 indicates that for all soils excepting sandy soil and highly clay soils, the range of soil moisture (under allowable soil moisture depletions of 50%, 40%, 30% and 20 % of total available soil moisture) fall within the operational range of the irrischeduler.

4. Conclusion

Irrischeduler is a much simpler device in comparison to a tensiometer but possesses all its positive attributes, therefore it can be used to schedule irrigations effectively. Farmers having their own tube wells or any other source of water may make a good use of irrischeduler and cut down on number and amount of irrigations and save the energy, time and money. The developed irrischeduler can be used to schedule irrigations in most soils except sandy soil and highly clay soils.

5. Acknowledgement

The authors gratefully acknowledge the financial support of National Agricultural Technology Project through its sub project on “improving skills and instrumentation for water application in fields for enhanced water use efficiency” for the present study.

6.References

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Table 1 Soil moisture levels at different irrigations of wheat 2001-2002
(Village Lakhan, District Hapur)

SN	Name of farmer	Source of water	Soil moisture contents observed at the time of different irrigations (%)						
1	Gyan Singh	C	10	12	17	10	-	-	-
2	Jagpal	T	20	21	22	20	19	22	-
3	Harchanda	C	15	17	20	13	-	-	-
4	Ramveer Singh	T	21	20	22	21	20	21	-
5	Dinesh Singh	T	21	21	22	23	20	20	-
6	Chhidda Singh	T	22	23	21	20	20	21	-
7	Jagpal Singh	C	12	12	16	11	-	-	-
8	Ompal Singh	T	21	23	20	22	21	23	-
9	Chandar	C	15	14	19	14	-	-	-
10	Bhule Singh	C+T	21	20	20	23	21	20	22
11	Veer Singh	C+T	22	24	22	23	25	22	24
12	Bhagvan Singh	T	21	23	21	23	22	-	-
13	Indraraj	C	15	15	18	14	-	-	-
14	Khoobi	C	16	17	18	14	-	-	-
15	Ranbhool Singh	C	11	13	17	10	-	-	-

C = Canal , T = Tubewell,

Table 2 Appropriate soil moisture levels for irrigation for wheat 2001-2002

(Village Lakhan, District Hapur)

SN	Name of farmer	Size of holding (ha)	Soil texture			Field Capacity (%)	Wilting Point. (%)	Appropriate Moisture for irrigation (%)
			Sand (%)	Silt (%)	Clay (%)			
1	Gyan Singh	5.6	56.5	35.28	8.22	21	9	15
2	Jagpal	5.6	44.5	44.00	11.5	24	10	17
3	Harchanda	5.6	44.5	39.28	16.22	25	11	18
4	Ramveer Singh	3.6	40.5	45.28	14.22	25	11	18
5	Dinesh Singh	3.2	37.78	45.72	16.5	26	11	19
6	Chhidda Singh	3.0	31.78	48.00	20.22	28	12	20
7	Jagpal Singh	2.4	45.78	41.72	12.5	23	9	16
8	Ompal Singh	2.0	36.5	44.28	19.22	27	12	19
9	Chandar	1.2	35.78	48.00	16.22	26	11	19
10	Bhule Singh	1.2	44.5	44.00	11.5	24	10	17
11	Veer Singh	1.1	31.78	50.00	18.22	28	12	20
12	Bhagvan Singh	1.0	36.5	44.28	19.22	27	12	19
13	Indraraj	1.0	33.78	50.00	16.22	27	11	19
14	Khoobi	0.7	32.5	45.28	22.22	28	13	20
15	Ranbhool Singh	0.15	56.5	35.28	8.22	21	9	15

Table 3. Inaccuracy in farmers decisions for scheduling irrigations

SN	Name of farmer	Range of soil moisture at the time of irrigations (%)	Soil moisture appropriate for irrigation (%)	Error in scheduling irrigations (%)
1	Gyan Singh	10 – 17	15	-33 to +13
2	Jagpal	19 – 22	17	+11 to +29
3	Harchanda	13 – 20	18	-27 to +11
4	Ramveer Singh	20 – 22	18	+11 to +22
5	Dinesh Singh	20 - 23	19	+ 5 to +21
6	Chhidda Singh	19 - 23	20	0 to +15
7	Jagpal Singh	11- 16	16	-31 to 0
8	Ompal Singh	20 - 23	19	+ 5 to +21
9	Chandar	14 - 19	19	-26 to 0
10	Bhule Singh	19 - 22	17	+17 to +35
11	Veer Singh	21 - 24	20	+10 to +25
12	Bhagvan Singh	21 - 23	19	+10 to +21
13	Indraraj	14 - 18	19	-26 to - 5
14	Khoobi	14 - 20	20	-30 to +10
15	Ranbhool Singh	10 - 17	15	-33 to +13

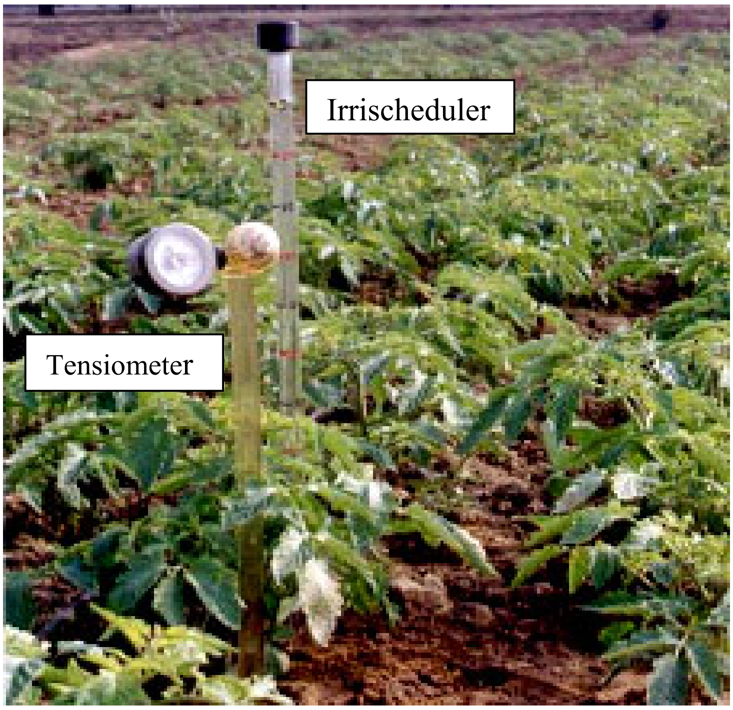

Figure 1. Irrischeduler installed next to a tensiometer in a tomato field for calibration

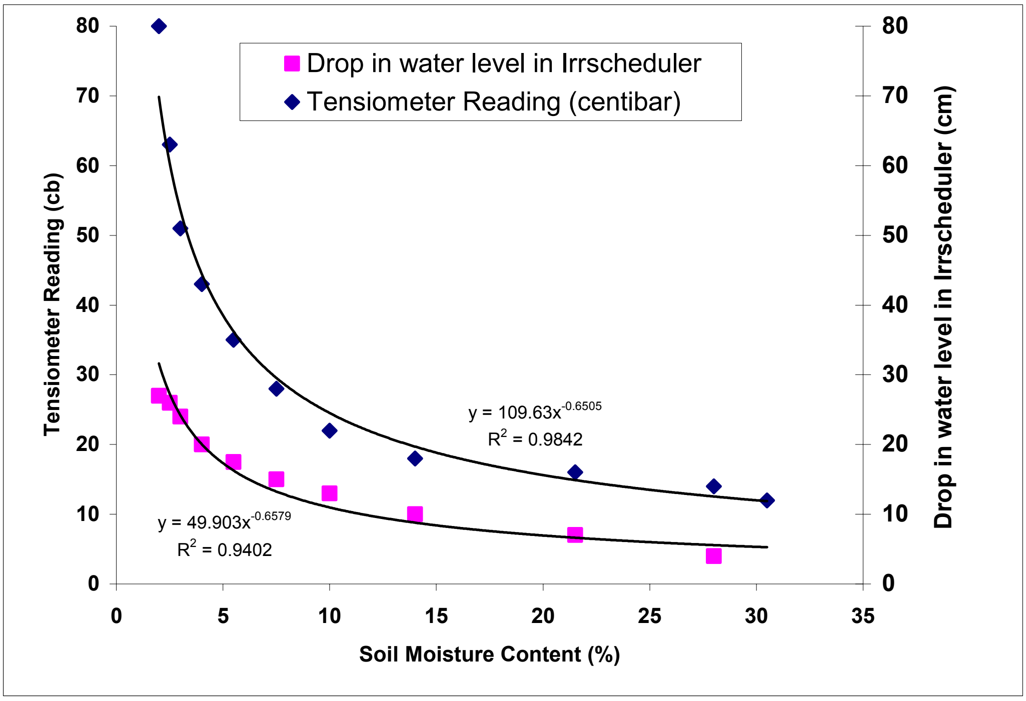

Figure 2 Characteristic curves of a tensiometer and an irrischeduler (Loamy sand soil)

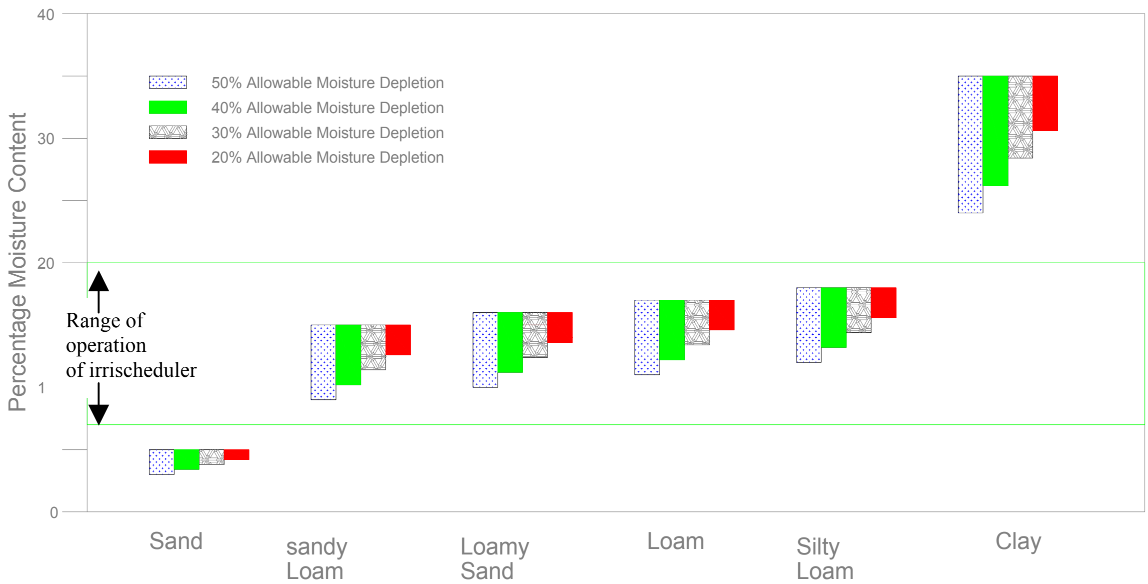

Figure 3 Range of operation of irrischeduler and allowable moisture in different soils