RELATIVE EFFICIENCY EVALUATION OF DRIP AND CONVENTIONAL METHODS OF IRRIGATION IN ASHGOURD AND CUCUMBER

By

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THESIS

Submitted in partial fulfilment of the requirement for the degree

Master of Science in Agricultural Engineering

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DECLARATION

I hereby declare that this thesis entitled "Relative efficiency evaluation of drip and conventional method of irrigation in Ashgourd and Cucumber" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that this thesis entitled "Relative efficiency evaluation of drip and conventional methods of irrigation in Ashgourd and Cucumber" is a record of research work done independently by Smt.Sheeja A.Andezhathu under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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20 4 -1989.

CERTIFICATE

We, the undersigned, members of the Advisory Committee of Smt.Sheeja.A.Andezhathu, a candidate for the degree of Master of Science in Agricultural Engineering, agree that the thesis entitled "Relative efficiency evaluation of drip and conventional methods of irrigation in Ashgourd and Cucumber" may be submitted by Smt.Sheeja.A.Andazhathu in partial fulfilment of the requirements for the degree.

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SYMBOLS AND ABBREVIATIONS

Agric	Agricultural
ASAE	American Society of Agricultural Engineers
CC	Cubic Centimetre(s)
C.D.	Critical difference
Cm	Centimetre(s)
Dept.	Department
Div.	Division
et al.	and others
FAO	Food and Agriculture Organisation
Fig	Figure
ha	Hectare(s)
hr	hour
ICAR	Indian Council of Agricultural Research
IRRI	International Rice Research Institute
J	Journal
KCAET	Kelappaji College of Agricultural Engineering and Technology
kg	kilogram(s)
km	Kilometre(s)
l	Litre(s)
min	Minute(s)
mm	Millimetre(s)
MSS	Mean sum of squares
No.	Number
pp	Pages
Proc.	Proceedings
Res.	Research
Rs.	Rupees
SS	Sum of squares
SEm	Error mean sum of squares
Sec	Second(s)
t/ha	tonnes per hectare
/	per
%	per cent
@	at the rate of

Introduction

INTRODUCTION

Irrigation is an age-old art and science, as old as civilization. The ever increasing population and the consequent need for additional food supplies are causing rapid expansion of irrigation throughout the world. As more water is to be given for industries and for the growing population, the demand for water is increasing day by day. Hence the allocation of water to agriculture will be reduced. Proper management of water resources, becoming progressively scarce is of utmost importance in this context.

Methods to increase productivity per unit area using less water are the basic needs of the day. Drip irrigation system has been recognised as a promising technology to achieve this objective. This technology of trickle or drip irrigation began its development in the early 1960's. Initial progress was sporadic even though several advantages in water management with trickle systems were recognised. Operators were reluctant to use the system because of its high initial cost and doubts regarding its reliability. Once the main problems were isolated and solutions developed to make the system reliable, the growers accepted the technology rapidly. Today drip irrigation is being used on crops which were earlier considered to be uneconomical.

Wild flooding, border strip, furrow and basin are the common surface methods of irrigation in our country. The water use efficiencies of these systems come only from 45 to 50%. But the drip method of irrigation is a step further and it has a very high water use efficiency of over 90% as it supplies water at the right place in the correct amount at the right time. It requires less water and less labour in comparison to other methods.

The drip irrigation method is characterised by the following features. 1. Water is applied at a low rate 2. Water is applied over a long period of time. 3. Water is applied near or into the plant's rootzone and 4. Water is applied by a low-pressure delivery system.

In drip irrigation, plants are irrigated frequently with a volume of water equal to the consumptive use of plants. Water is delivered in drops at the soil surface near the base of plants. Frequent application of water keeps the soil always at the optimum condition of moisture for plant growth.

Water plays a vital role in all stages of plant growth. Nature has given each stomata of leaf two guard cells capable of closing the pore to prevent the level of water loss that could cause permanent damage to the leaf. The time at which the stomata will close on any particular day will depend on the evaporation demand for that day and on the ability of the tree to extract water from the soil at required rate. Between two irrigations, the plant is not able to extract water at a rate that will meet its maximum needs. Hence, it is better if the leaves produce sugar for a restricted number of hours each day rather than provide a luxury supply for part of the time and drought at other times. This is the concept on which daily flow drip irrigation is based. Hence by drip method, it becomes possible for daily maintenance of an adequate section of the rootzone of a plant at nearby field capacity during the growing and productive cycle.

According to a report in 1984, drip irrigation was practiced on some 416,000 ha of which 185,000 ha lie in USA, 82,000 ha in Israel, some 46,000 ha in Europe including the USSR, 8000 ha in China with small area in many developing countries. It may well be that the world wide figure today is double the above value. Though drip irrigation has come of age technologically, it is still in its infancy as far as the extent of the area irrigated is concerned. We can expect coming decade to see much larger areas under drip systems. The drip irrigation system is more useful than sprinkler systems in arid areas.

The Kerala Agricultural University at its Agronomic Research Station, Chalakudy, developed a low cost drip irrigation system in 1977. Locally available materials are used for the system and it requires no special skill in its fabrication, installation and operation. The total head required for working the system is only about one metre. Water is pumped into a storage tank having an elevation of one metre above the field level and is conveyed from tank to field through a main pipe. Smaller diameter pipes are used as laterals and they are connected at suitable intervals, on both sides of main pipe. Distributors are connected to laterals through microtubes.

The system lasts at least for 8 to 10 years. Once installed, additional labour is not necessary to operate the system compared to the basin method of irrigation.

A relative efficiency evaluation of low cost drip irrigation and basin method of irrigation is done in this study for two vegetable crops, Ashgourd and Cucumber.

Review of Literature

REVIEW OF LITERATURE

A. Drip in general

Drip irrigation is an improved method of irrigation. The irrigation system is designed to deliver controlled amounts of water directly to the plant. Current drip irrigation technology dates back to Blass in 1964 who used the method in Israel in early 1960's.

By increasing frequency of water application, the actual availability of water does increase owing to establishment of relatively moist environments in the main root system throughout the irrigation cycle (Black 1969, Goldberg, 1971). Drip irrigation is a multi disciplinary agricultural practice and has enormous potential and possibilities (Goldberg, 1971).

The basic principle of drip irrigation is to replace water and sometimes nutrients used by plants during the previous day and to supply these requirements without wastage or stress to the plant (Swan and Coffman, 1971).

The design of a drip irrigation system is based on the hydraulics of pipe flow. The pressure distribution along a drip irrigation line is controlled by the energy drop through friction and energy loss or gain due to slope. If the pressure distribution along a lateral line can be determined, uniform irrigation can be achieved by adjusting the length and size of microtubes used (Kenworthy, 1972), by adjusting the size of emitters (Myers and Bucks, 1972) and by slightly adjusting the spacing between the emitters (Wu and Gitlin, 1973). The basic hydraulic concepts of drip irrigation were developed by Wu and Gitlin (1974). The design charts for lateral lines were introduced by them.

George (1977) developed a drip irrigation technique by introducing the distributor. The distributor was made from a polyethylene pipe used for laterals, plugged at both ends with plastic caps.

One of the explanations offered for the beneficial effect of trickling is the prevention of leaf scorch through elimination of leaf wetting. This effect is especially pronounced when irrigation water is saline.

But its importance in case of non-saline water has not yet been conclusively established (Gornat et al., 1973). Goldberg et al. (1976) defined drip irrigation as a new agro-technical approach for growing crops under highly controlled conditions of soil moisture, fertilization, salinity and pest control. It has significant effect on crop response, timing of harvest and yield. Saline water could be used safely for irrigation of crops with drip irrigation (Goldberg, 1971; Hiller et al., 1975).

According to Davis (1975) and Shoji (1977) under drip irrigation real energy conservation can also be obtained because of the reduction in amount of water pumped.

Fruits and vegetables are the primary receipients of drip prrigation system and they are made to flourish in the sandy soils of Israel deserts. This method was proved superior to other methods in yield under desert conditions (Sivanappan and Karai Gowder, 1977). Drip irrigation had no adverse effect on soil structure (Zerbig and Chiaranda, 1979). The economic advantages of the drip are significantly impressive over the latter when the water saved in the drip is profitably used for area expansion (Sivanappan et al.,1983).

A number of farmers have taken up this system for coconut gardens, orchard and vegetable crops. Cost of the system depends on spacing of crops, type of materials selected, source of water . (Sivanappan, 1983). King and Andreson (1987) said that trickle irrigation is well suited for farmstead irrigation for several reasons. 1. Physical layout of a trickle system having a long narrow wetted area, suits shelter belts. 2. Low pumping rates can be used effectively. 3. The low pressure required reduces pumping costs. 4. Water is applied just where it is needed.

Drip irrigation has the capability of eliminating stress on any crop you grow, and that is the secret to obtain maximum yield and uniformity (Don Dale, 1986). According to Phene (1988) as long as the plant roots are being fed, a dry surface is the best for many fruits and vegetables.

Aquanova, Inc. of Phoenix (USA) installed a drip system irrigating more than 4000 hectares of cotton at Paloma Ranch, Arizona. Over 20,000 km of tubing and nearly 22 million emitters were used in a massive operation (IRRI, 1984).

According to Sheela (1988), who conducted the experiment in the same field, the average conveyance loss of water in the basin method of irrigation while irrigating one hectare of land was 27.7%.

B. Comparison with other irrigation methods

On steep hills, Furrow irrigation and under strong wind condition, sprinkler irrigation are not effective with respect to water saving (Seginer, 1967). Griffin (1977) reported that growers using drip indicated 25-50% saving in water, saving in operational cost, 25% higher yield and better quality crop as compared to sprinkler system. Drip irrigation resulted in considerable increase in water use efficiency over furrow and sprinkler irrigation (Cole, 1971; Bernstein and Francois, 1973; Hiller and Howell, 1973; Black and West, 1974).

Drip irrigation is useful for fruits and vegetables and a saving of 30% in water use and increase in yield by 50% have been claimed under this system

(Sivanappan *et al.*, 1972). Much saving of water is achieved by restricting water supply to the extent of most efficient root zone (Dasberg and Steinhardt, 1974).

Work done with strawberries in South California showed that in drip irrigation, water used is less than 50% of that used in control (Remer, 1971). Drip irrigation of raspberries compared to sprinkler irrigation resulted in a 18.4% reduction in water requirement and 10.9% less production cost/100 kg fruit.

Sivanappan *et al.* (1976) reported response of banana to drip irrigation at Coimbatore and compared it to check basin method. Analysis of data showed no significant difference in the yield of banana between check basin method and the drip irrigated plots. However, the quantity of water used in the drip irrigated plots was only one fourth of check basin method. Experiments conducted to compare drip irrigation with conventional surface irrigation showed that the former saves upto 80% water, reduces weed growth, improves germination and gives the same or sometimes more yield (Sivanappan, 1977). Muthukrishnan *et al.* (1983) reported that no adverse effect on bunch weight in banana was observed although water applied was only one fourth of the conventional system.

The experiments conducted with vegetables and cash crops at Tamil Nadu Agricultural University, Coimbatore, showed that the water used in drip method was only 1/2 to 1/5 of the control (surface method) and at the same time yield was increased by 10 to 40% in many crops (Sivanappan et al., 1974; Sivanappan, 1975; Sivanappan and Palaniswamy, 1978).

Drip irrigation resulted in significant increase in production and water use efficiency of onion, sugar beet and potato at Hissar and of potato at Jobner in comparison with surface irrigation (AICSRWMSS, 1975). Vegetable crops under drip irrigation at Jodhpur on loamy sand soil resulted in higher yield and water use efficiency (Singh, 1979).

Experiments in cotton have showed that the water saving in drip irrigation is 47% as compared to surface irrigation (Sivanappan and Kumar, 1983).

Abrol and Dixit (1971) compared drip method with conventional basin irrigation in India for onions and okra. They found significant increase in yield and water use efficiency in the drip method which was ascribed to increase/ availability of soil moisture at low tensions and reduced surface evaporation.

Yield of tomatoes under drip irrigation was double that under sprinkler irrigation. Apart from this, the fruit was more uniform which meant less grading and sorting (Grobellar, 1971). Tomato crop at Coimbatore yield 22.23 t/ha on drip system as compared to the corresponding control yield of 17.29 t/ha. The savings in water by drip irrigation for different crops vary from 60 to 80% (Sivanappan and Padmakumari, 1980). Anne Goldstein (1988) reported that the 247 t/ha harvest in California broke the record of 185.25 t/ha for irrigated field crop of tomatoes. And yet less water than normal was needed to irrigate tomatoes which made up the record yield. The technique used was subsurface drip irrigation

Drip irrigated apple orchard produced 81.8% more total yield than when it was flood irrigated during the previous season (Grobellar, 1971). In case of drip irrigated grapes for wine production, a tremendous yield increase (190%) was obtained compared to production of previous years which was flood irrigated. Drip system of irrigation was found to produce better grapes and better wine. Drip system was the most ideal method for supplying the accurate quantity of water for each variety of vine (Ivan, 1983).

Drip was superior to sprinkler irrigation as expressed in greater annual leaf and bunch production, fruit size and total yield in date palms compared with furrow irrigation (Reuveni, 1974).

Bucks <u>et al</u>. (1974) observed that maximum production of cabbage was almost identical under drip and furrow irrigation. They viewed that drip irrigation has the potential to reduce irrigation water requirement but not consumptive use of water under many field conditions. An experiment laid to compare the efficiency of drip irrigation indicated that vegetables like amaranthus and bhindi respond well to drip irrigation (Anon, 1977-78). The work done at the Central Aridzone Research Institute, Jodphpur showed that drip irrigation is more suited to high value widely spaced vegetables and plantation crops in the sandy arid plains (Sivanappan and Padmakumari, 1980). Cucumbers were drip irrigated to evaluate the water requirement and effect of silver coated plastic mulch on crop performance. The moist treatment gave significant increase in crop yield compared to wet and dry treatments. The use of plastic mulch further enhanced production by 4.6 t/ha (Goyal and Allison, 1983).

Maize developed more rapidly and gave higher yields in drip irrigation (Goldberg et al., 1976). Trials on drip irrigation in sugarcane conducted in Hawai showed equal or better yields than with furrow irrigation (Gibson, 1975).

The work done by Koshy Varghese (1985) at Kerala Agricultural University showed that there was no significant difference in banana yield under drip and basin methods of irrigation. The days taken for flowering were not significant between different treatments in the above study. The trial on banana conducted at Coimbatore showed that even though yield was reduced by 2 kg/plant, the water saving was 3/4th of the control system. It was also noticed that plants in the plot irrigated by drip method flowered earlier than those in control. Sheela (1988) showed that drip method of irrigation gave higher yields both in amaranths and brinjal. In case of amaranthas there were no significant differences in plant height and dry matter percentage, between treatments. In case of brinjal, no significant difference was noticed in days taken for flowering and fruits per plant between treatments. There was significant difference in plant height between treatments.

Materials and Methods

MATERIALS AND METHODS

The irrigation experiment was done under field conditions and ta comparison between drip method and basin method was made. The drip net work was working on a low pressure. In both methods, the experiment was done with three levels of irrigation. The materials used for the system were purchased locally. The fabrication was done by unskilled labourers, since the system was very simple.

A. Principles of the system

Drip irrigation is one of the latest methods of irrigations and in this method plants are watered frequently with only the required quantity of water. Water is needed only in the root zone of crops and this is achieved through this system.

This system avoids unnecessary wetting of entire soil surface and this minimises losses due to evaporation. Deep percolation and conveyance losses are also avoided

Water is applied to the soil surface, very near to the root zone, through microtubes. The microtubes are connected to the lateral pipes which in turn are connected to main pipes. The main pipe is connected to a storage tank. The rate of discharge of each microtube varies from 1 to 5 l/hr. The water applied was just sufficient to maintain the soil at or near field capacity and thus maintain moisture level in the fields at the optimum levels.

B. Location of the field

The experimental field was located in the Vegetable Research Plots of the Department of Olericulture, College of Horticulture, Vellanikkara. Surrounding three sides (viz. northern, eastern and southern) were at a higher elevation than the experimental plot.

C. Layout of the experiment

The experiments on Ashgourd and Cucumber were laid out separately in randomised block design. Three different rates of water in two methods of irrigation were used. Hence for each crop there were six treatments. The rates were decided depending on IW/CPE ratio i.e. the ratio of irrigation water applied to cumulative pan evaporation. The treatments were labelled as T_1, T_2, T_3, T_4, T_5 and T_6. The following table gives the discription of these treatments.

Treatments	Irrigation method	IW/CPE
T_1	Drip	1.00
T_2	Drip	0.70
T_3	Drip	0.40
T_4	Basin	1.00
T_5	Basin	0.70
T_6	Basin	0.40

Each treatment was replicated four times and these replications were labelled as R_1, R_2, R_3 and R_4. Each replication containing all the treatments was laid out in one block. Treatments within the block were selected at random. For each crop there were six treatments and four replications which made a total of 24 plots. The net size of the individual plot for each crop was 6 m x 3 m and net area of experimental plot for such crop was 432 m^2. Each plot was separated by a bund having 30 cm width at bottom and 20 cm width at top. The gross area of the experimental plot was 776.04 m^2 for each crop.

The spacing of the plants was 4.5 m x 2 m as per recommendations from the package of practices. At each corner of the plots, pits were dug out with 60 cm diameter and 40 cm depth. There were four pits in each plot. Cowdung was applied as a basal dose. The fertilizers and plant protection practices were applied as per the recommendations in package of practice. Nitrogen was applied as urea, phosphorus as super phosphate and potassium as muriate of potash. The fertilizers, cowdung and top soil were mixed together in each pit and watered. The seeds which were put in water for four hours were sown in the pits @ 5/pit. Within 4-5 days the seeds germinated. After ten days the unhealthy plants were removed from each pit and only two plants were allowed to grow in each pit.

For trailing cucumber and ashgourd dried twigs were spread on the ground. Harvesting was done from all the plants.

The field layout and an individual plot are diagramatically shown in Fig.1 to 3.

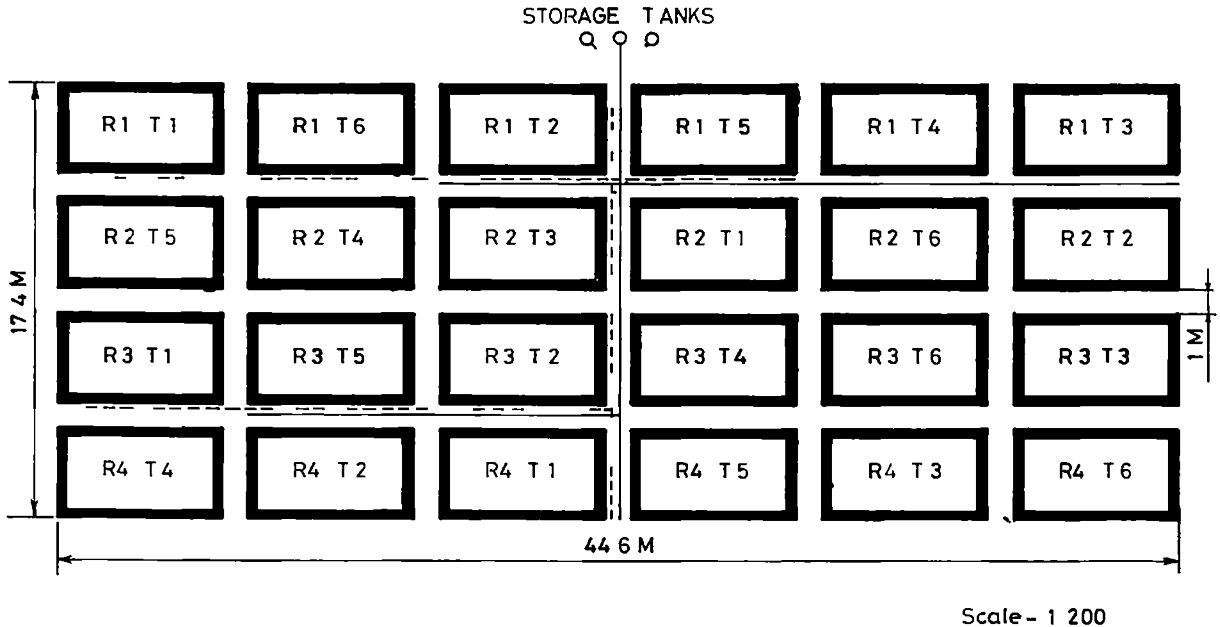


Fig 1 LAYOUT OF ASHGOURD FIELD

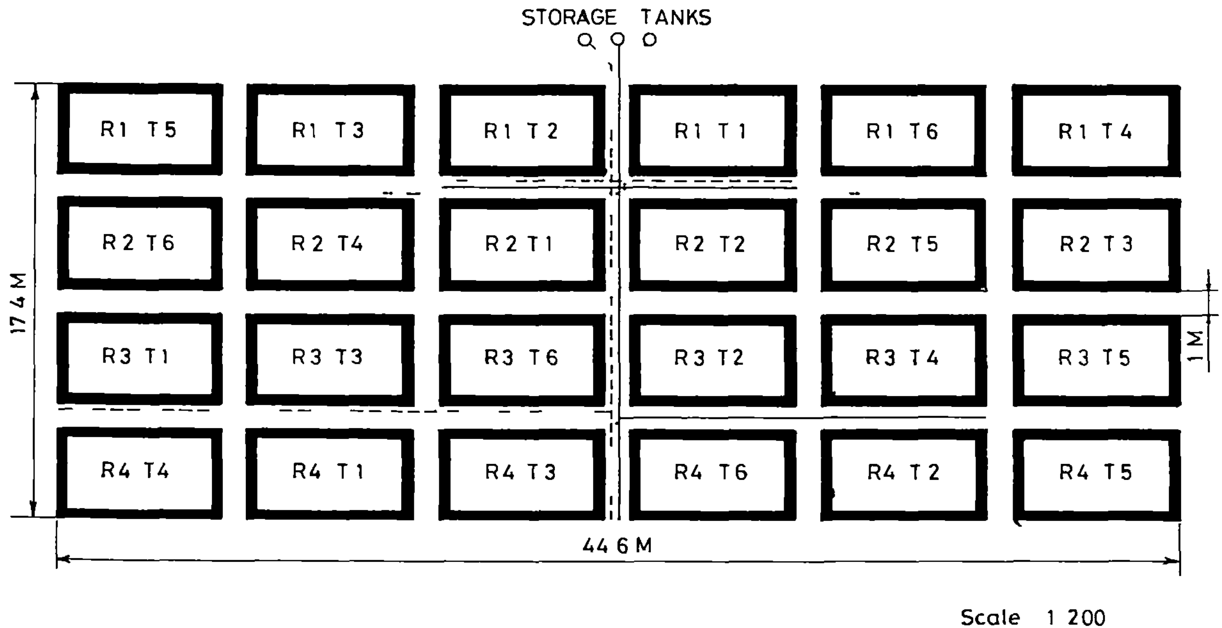


Fig 2 LAYOUT OF CUCUMBER FIELD

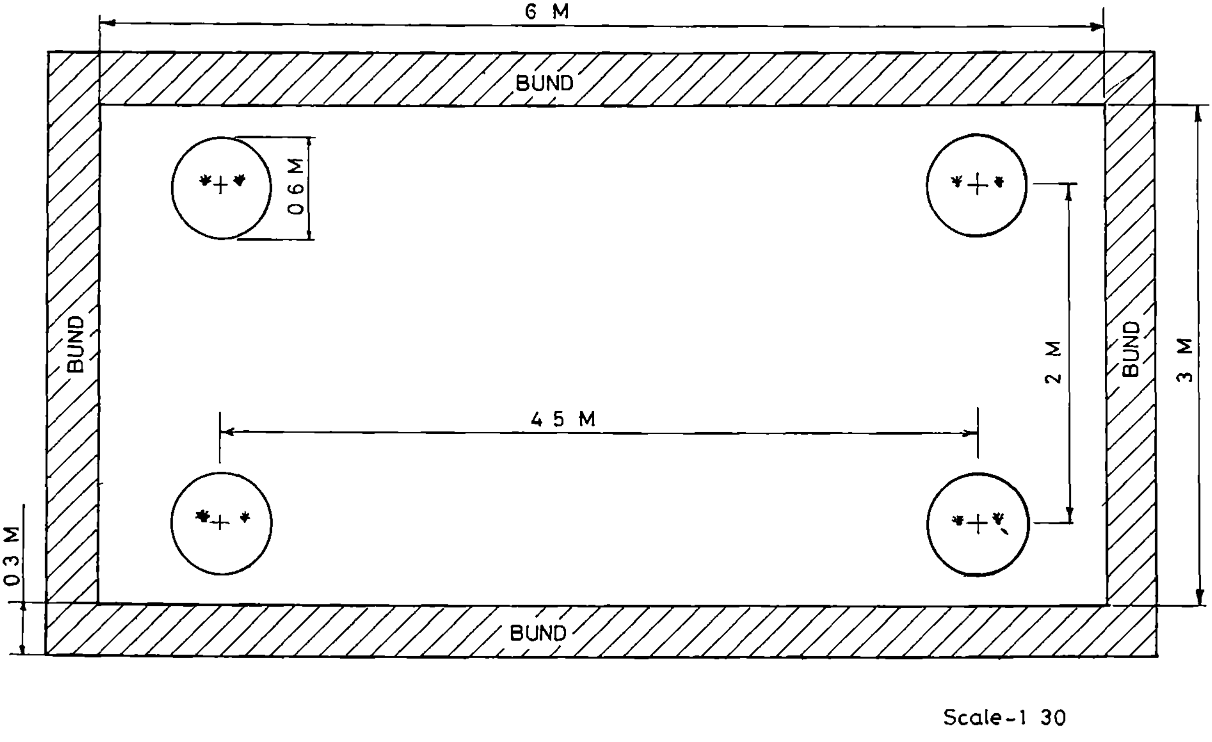


Fig 3 AN INDIVIDUAL PLOT

D. Irrigation channels

The pond near the main gate of University was the source of water supply. The water pumped from the pond was brought to a point, very near to the field, through pipes. Water from the pipe was diverted to the main channel which was near the longitudinal side of the experimental field. From the main channel water was diverted to sub channels. From the sub channels water was given to individual pits of treatments T_4, T_5 and T_6. The quantity of water was measured using an orifice plate

E. Schedule of irrigation

During the initial days common irrigation was given to all the plots. Irrigation schedule was based on IW/CPE ratios in both methods, i.e. depending on the open pan evaporation value.

Drip irrigation was given every day depending on the evaporation value of the previous day. For example, if the evaporation value of the previous day was 6 mm, in treatment T_1 (IW/CPE = 1), the depth of irrigation water given was 6 mm. For treatment T_2 (IW/CPE = 0.7), the depth of irrigation water given was 4.2 mm and for

Table 1. Irrigation schedule for ashgourd

Date	Evaporation	Rainfall mm	Quantity of water in litres/plot T1	T2	T3	Evap. x 0.7 mm	Evap. x 0.4 mm	Cumulative value of computed ET for different treatments T4	T5	T6
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
March										
30	4.3	-	-	-	-	3.01	1.72	4.3 I_4	3.01 I_5	1.72
31	6.0	-	77.4	54.18	30.96	4.2	2.4	10.3	7.21	4.12
April										
1	6.1	-	108.0	75.60	43.20	4.27	2.44	16.4	11.48	6.56
2	6.7	-	109.8	76.86	43.92	4.69	2.68	23.1	16.17	9.24
3	4.9	-	120.6	84.42	48.24	3.43	1.96	28.0	19.60	11.20
4	7.0	-	88.2	61.74	35.28	4.90	2.80	35.0	24.50	14.00
5	6.4	-	126.0	88.20	50.40	4.48	2.56	6.4 I_4	28.98	16.56
6	6.5	-	115.2	80.64	46.08	4.55	2.60	12.9	33.53	19.16
7	4.6	-	117.0	81.90	46.80	3.22	1.84	17.5	3.22 I_5	21.10
8	6.8	-	82.8	57.96	33.12	4.76	2.72	24.3	7.98	23.72
9	5.0	-	122.4	85.68	48.96	3.50	2.00	29.3	11.48	25.72
10	7.0	35.0	90.0	63.00	36.00	4.90	2.80	0 I_4	0	0
11	6.0	12.8	-	-	-	4.20	2.40	0	0	0
12	6.8	20.8	-	-	-	4.72	2.72	0	0	0

(Contd.)

Table 1 (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
13	5.6	-	-	-	-	3.92	2.24	5.6	3.92	2.24
14	6.0	25.4	100.8	70.56	40.32	4.20	2.40	0	0	0
15	5.3	-	-	-	-	3.71	2.12	5.3	3.71	2.12
16	6.0	-	95.4	66.78	38.16	4.20	2.40	11.3	7.91	4.52
17	5.6	5.0	108.0	75.6	43.20	3.92	2.24	11.9	7.91	1.76
18	5.2	35.4	-	-	-	3.64	2.08	0	0	0
19	5.7	-	-	-	-	3.99	2.28	5.7	3.99	2.28
20	5.3	-	102.6	71.82	41.04	3.71	2.12	11.0	7.70	4.40
21	5.0	-	95.4	66.78	38.16	3.50	2.00	16.0	11.20	6.40
22	5.5	-	90.0	63.00	36.00	3.85	2.20	21.5	15.05	8.60
23	5.6	-	99.0	69.3	39.60	3.92	2.24	27.1	18.97	10.84
24	5.5	1.6	100.8	70.56	40.32	3.85	2.20	32.6	22.82	13.04
25	6.4	5.8	70.2	49 14	28.08	4.48	2.56	0 I_4	22.82	9.80
26	5.7	-	-	-	-	3.99	2.28	5.7	26.81	12.08
27	6.7	-	102.6	71.82	41.04	4.69	2.68	12.4	31.50	14.76
28	5.6	-	120.6	84.42	48.24	3.92	2.24	18.0	3.92	15.36
29	4.9	3.6	100.8	70.56	40.32	3.43	1.96	18.0	3.92	15.36
30	6.0	-	-	-	-	4.20	2.40	24.0	8.12	17.76

(Contd.)

Table 1 (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
May										
1	5.0	3.7	108.0	75.6	43.2	3.5	2.0	0	0	0
2	4.8	-	-	-	-	3.36	1.92	4.8	3.36	1.92
3	4.5	-	86.4	60.48	34.56	3.15	1.80	9.3	6.51	3.72
4	4.4	4.4	81.0	56.7	32.40	3.08	1.76	9.3	6.51	1.08
5	3.9	-	-	-	-	2.73	1.56	13.2	9.24	2 64
6	4.0	-	70.2	49.14	28.08	2.80	1.60	17.2	12.04	4.24
7	4.4	-	72.0	50.40	28.80	3.08	1.76	21.6	15.12	6.00
8	6.0	-	79.2	55.44	31.68	4.20	2.40	27.6	19.32	8.40
9	5.2	-	108 0	75.6	43.20	3.64	2.08	32.8	22.96	10.48
10	5.2	-	93.6	65.52	37.44	3.64	2.08	5.2 I_4	26.60	12.56
11	4.2	-	93.6	65.52	37.44	2.94	1.68	4.2	29.54	14.24
12	5.7	-	75.6	52.92	30.24	3.99	2.28	9.9	3.99 I_5	16.52
13	4.8	4.0	102.6	71.82	41.04	3.36	1.92	9.9	3.99	14.44

I_4 = Irrigation of plots getting treatment T_4
I_5 = Irrigation of plots getting treatment T_5
I_6 = Irrigation of plots getting treatment T_6

Table 2. Irrigation schedule for cucumber

Date	Evaporation	Rainfall (mm)	T_1	T_2	T_3	Evap. x 0.4	Evap. x 0.4	Cumulative value of computed ET for different treatments		
								T_4	T_5	T_6
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
May										
8	6.0	-	-	-	-	4.2	2.4	6 I_4	4.2 I_5	2.4 I_6
9	5.2	-	108.0	75.6	43.2	3.64	2.08	11.2	7.84	4.48
10	5.2	-	93.6	65.52	37.44	3.64	2.08	16.4	11.48	6.56
11	4.2	-	93.6	65.52	37.44	2.94	1.68	20.6	14.42	8.24
12	5.7	-	75.6	52.92	30.24	3.99	2.28	26.3	18.41	10.52
13	4.8	4.0	102.6	71.82	41.04	3.36	1.92	26.3	17.77	8.44
14	5.2	-	-	-	-	3.64	2.08	31.5	21.41	10.52
15	5.6	-	93.6	65.52	37.44	3.92	2.24	5.6 I_4	25.33	12.76
16	4.6	-	100.8	70.56	40.32	3.22	1.84	10.2	28.55	14.6
17	4.3	-	82.8	57.96	33.12	3.01	1.72	14.5	31.56	16.32
18	5.7	-	77.4	54.18	30.96	3.99	2.28	20.2	3.99 I_5	18.60
19	6.4	-	102.6	71.82	41.04	4.48	2.56	26.6	8.47	21.16

(Contd.)

Table 2 (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
20	6.0		115.2	80.64	46.08	4.2	2.4	32.6	12.67	23.56
21	5.9	-	108.0	75.6	43.20	4.13	2.36	5.9 I_4	16.80	25.92
22	4.5	1.8	106.2	74.34	42.48	3.15	1.8	10.4	19.95	27.72
23	5.8	-	48.6	34.02	19.44	4.06	2.32	16.2	24.01	30.04
24	2.9	1.6	104.4	73.08	41.76	2.03	1.16	19.1	26.04	1.16 I_6
25	5.7	4.6	-	-	-	3.99	2.28	19.1	25.43	0
26	4.0	-	-	-	-	2.8	1.6	23.1	28.23	1.6
27	5.4	1.2	72.0	50.4	28.8	3.78	2.16	28.5	32.01	3.76
28	3.2	4.2	75.6	52.92	30.24	2.24	1.28	27.5	0	0
29	3.5	1.8	-	-	-	2.45	1.4	31.0	2.45	1.4
30	0.8	18.2	-	-	-	0.56	0.32	0	0	0

I_4 - Irrigation of plots getting treatment T_4

I_5 - Irrigation of plots getting treatment T_5

I_6 -Irrigation of plots getting treatment T_6

treatment T_3 (IW/CPE = 0.4) the depth of water given was 2.4 mm.

When the amount of rainfall was less than 2 mm for a particular day, that rain was not taken into consideration. Also when evaporation minus rainfall was less than 2 mm, its value was taken as zero.

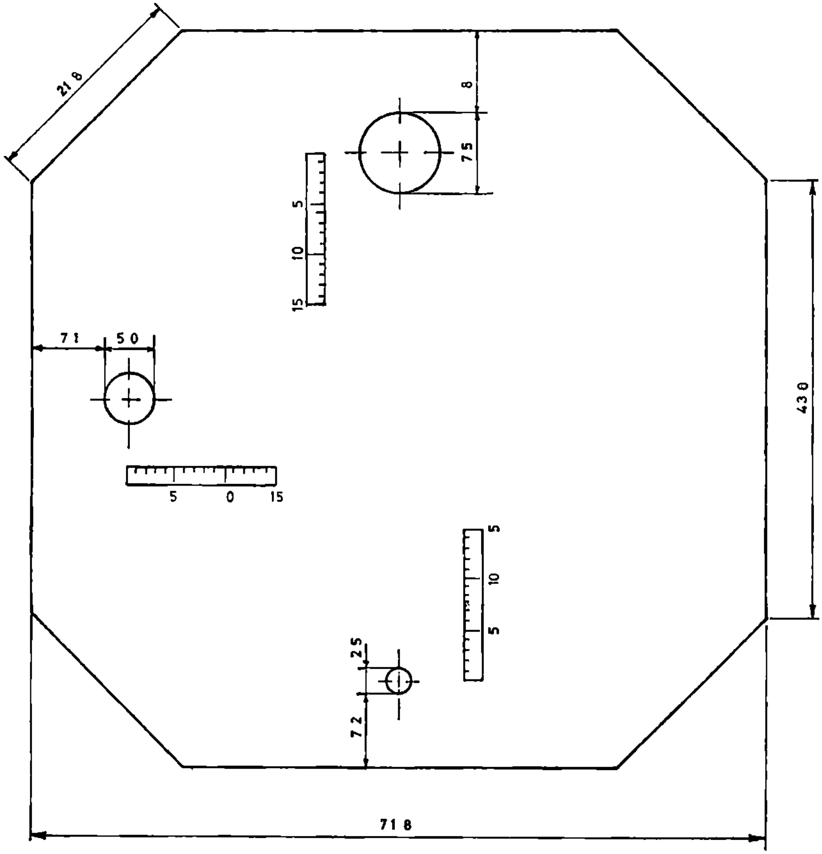
In the basin method, the depth of irrigation water for one irrigation was kept as 30 mm and the frequency of irrigation was changed for the different treatments depending on the cumulative pan evaporation. Plots receiving treatment T_4 with IW/CPE = 1 were irrigated when the cumulative pan evaporation reached › 30 mm Plots receiving treatment T_5 (IW/CPE = 0.7) were irrigated when cumulative pan evaporation x 0.7 reached ~ 30 mm. Plots receiving treatment T_6 (IW/CPE = 0.4) were irrigated when cumulative pan evaporation x 0.4 reached t› 30 mm

The details of irrigation are given in Tables 1 and 2. Rain occurred on many days during the experiment and the irrigation was affected by such rainy days On such days irrigation was done after considering the amount of precipitation. For example, when the evaporation was 6 mm and rainfall was more than 6 mm on a particular day, no irrigation was done on the next day in the drip irrigated plots. If the rainfall was less than 6 mm that was subtracted from the pan evaporation value and the quantity of water applied as irrigation was equivalent to the balance.

F. Basin irrigation and its measurement

The water brought through the sub channels was diverted to individual basins after careful measurement using a circular orifice plate. It was made of 18 mm guage M.S. sheet with accurately machined circular openings or orifices. These openings had diameters of 2.5 cm, 5 cm and 7.5 cm. Adjacent to each orifice a plastic scale was fixed to the plate on the upstream and downstream face of the orifice plate. The zero reading of the scale coincided with the centre of orifice. The details of orifice plate is given in Fig 4. The quantity of irrigation water was measured by placing the orifice plate in the sub channel just above the plot which was to be irrigated.

The discharge through the orifice was calculated by the formula.



Scale 1 5
All dimensions in c m

Fig 4 ORIFICE PLATE

$$Q = 0.61 \times 10^{-3} \quad a \sqrt{2 g H},$$

Where Q = discharge through orifice (1/Sec)

a = area of cross section of orifice (cm^2)

g = accelaration due to gravity (cm/sec^2) (981 cm/Sec^2)

H = Depth of water over the centre of the orifice in case of free flow orifice or the difference in elevation between water surface at upstream and downstreams stream faces of orifice plate in case of submerged orifice (cm).

The water which passed through the orifice was allowed to flow through the sub-channel for some time until a steady flow was reached. Then it was diverted to the basin by making an opening in the field bund. The earth removed from the field bund was used to stop the flow of water through the sub channel. For this the irrigation water needed was 270 litres. In order to determine the time required to supply 270 litres of water for various heads through 7.5 cm and 5 cm diameter orifices, a ready reckoner was prepared. This is given in appendices 1 and 2. As the water started to flow to the basin the time was noted and the head of water over the orifice plate was also noted. Hence the time needed to divert 270 litres of water was taken from the ready reckoner. When this time was reached, the field bund was closed. When the quantity of water coming through the sub channel was low, 5 cm diameter orifice was used.

G. Drip irrigation system

The required amount of water was given to the rootzone of the plants in drip irrigated plots through 2 mm microtubes. The microtubes were connected to distributor which in turn was connected to the lateral. The lateral pipe was connected to the main pipe and the main pipe to the storage tank. Each stage is explained under separate headings.

I. Storage tank

Oil drums of 200 litres capacity served the purpose of storage tank. The drums were kept at a higher elevation than the experimental field. The earthen embankment on which the drums were kept had a height of about 1 m. So the minimum available head was 1 m.

The maximum daily evaporation was assumed to be about 10 mm at Vellanikkara. To meet this evaporation, the quantity of irrigation water required for one T_1 plot having 18 m^2 net area, was 180 litres. Since there were four replications, the total quantity of water needed was 720 litres. Hence four number of 200 l capacity oil drums were used as storage tank for treatment T_1. The drums were connected at bottom using 25 mm GI pipe. The GI pipes were welded to the drums and the adjacent pipes connected using a GI unions. A set of three drums was used for treatment T_2 and another set of 2 drums was used for treatment T_3. All together there were nine drums for irrigating the drip irrigated plots of one crop. The outlet from each set of drum was provided with a 1" wheel valve. The wheel valve was connected to a 20 cm long threaded GI pipe (25 mm) and the GI pipe was welded to the bottom of the drum. About 5 cm length of GI pipe was extended into the drum. The inside end was covered with a plastic wire mesh to filter the impurities from entering into the pipe. The wheel valve was very helpful in controlling the rate of flow of water. The wheel valve was kept fully closed during

Plate I Storage tanks for drip irrigation

Plate II Main to lateral connections

the time of filling of water. The drums were filled using a hose pipe which was connected to the pipeline passing through the nearby experimental field

2. Main pipes

Black polythylene pipes of 25 mm diameter were used as the main pipes. As the system worked on low pressure, the cheapest locally available pipes were used for the purpose. For each treatment one main pipe was used. Hence for a single crop there were three main pipes. These three pipes were laid along the middle of the experimental field. Air vents were provided at the free ends of main pipes. This was done to avoid the obstruction of flow of water due to the entrapped air inside the pipe. The air vents were provided by keeping the free ends open and above the water level of the storage tank. For achieving this, wooden poles were fixed on the ground and each main pipe was tied to the wooden pole. As the wheel valve was opened for starting irrigation, the entrapped air escaped through this open end and bubbles could be seen till the flow of air particles were over.

3. Lateral pipes

12 mm diameter black polyethylene pipes were used as laterals. The laterals were connected to the

main pipe by means of 'Tee' joints. Locally available Tees were purchased for this purpose. As the main pipe was running along the middle of the field, laterals were provided on either side perpendicular to main pipe depending upon the position of drip irrigated plot. In between two rows of plots one lateral for one treatment was laid out. The free ends of the lateral pipes were tied to wooden poles and kept at a higher elevation than the water level in the storage tank. Main to lateral connection is shown in Fig. 5.

4. Microtubes

Commercially available pvc pipes of 2 mm diameter were used as microtubes. These pvc pipes served the purpose of drippers. For the three different rates of irrigation, tubes having three different colours were used. The microtubes were connected to the laterals by making holes having slightly lesser diameter than the external diameter of the microtubes and pushing the microtube into these holes for tight fit. The microtube attached to the lateral was connected to the distributor. This connection also was done in a similar manner. As the system was working on low pressure, these joints were

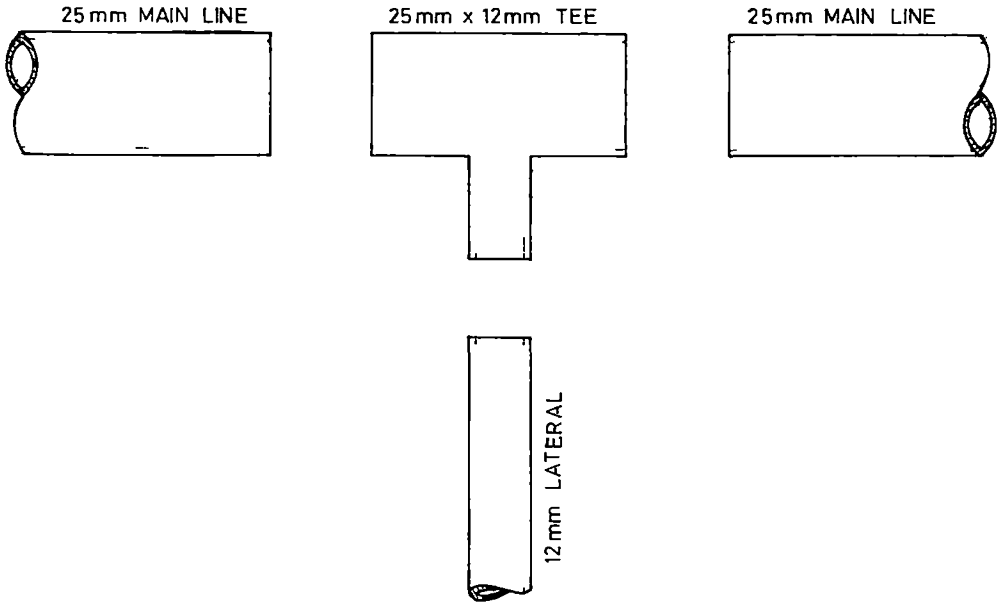


Fig 5 MAIN TO LATERAL CONNECTION

leakproof. The layout of laterals and microtubes in a plot is shown in Fig.6.

5. Distributors

The rate of discharge through the microtube connected to the lateral was about 10 to 20 lit/hr. But the accepted discharge for a conventional drip irrigation system was 1 to 5 lit/hr, depending upon the diameter of microtube. The function of distributor was to reduce the high discharge to a low discharge. The distributor was developed at the Agronomic Research Station, Chalakudy in the year 1977.

In the absence of a distributor, the high rate of discharge would cause the wetting of a larger surface area which in turn would increase the evaporation from soil surface. So by using a distributor the efficiency of the system was increased.

The distributor was made from 12 mm diameter polyethylene pipe. The pipe was cut into pieces of 15 cm length and each piece was plugged at both ends using 12mm pvc plugs which were commercially available. The laterals were connected to distributors using microtubes. From a

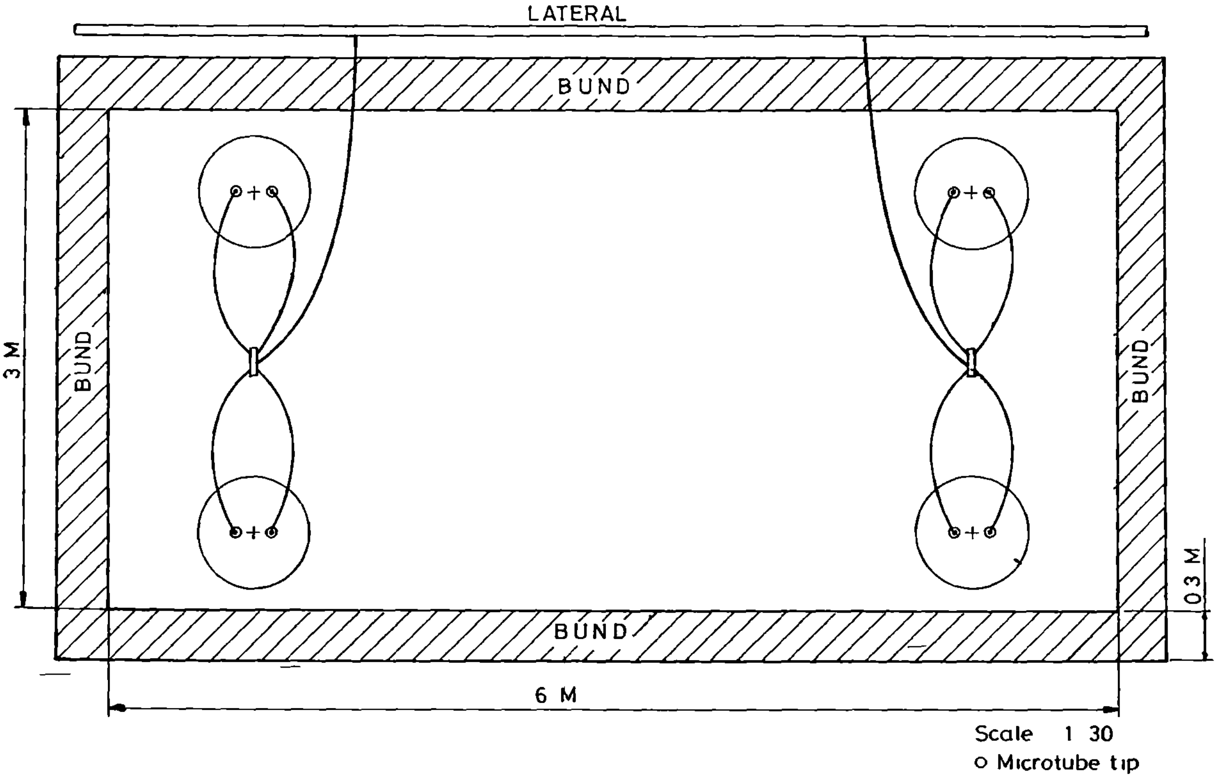


Fig 6 DETAILS OF DRIP IRRIGATED PLOT

single distributor, four microtubes were taken out, which functioned as drippers (Fig.7). There were two distributors in each drip irrigated plot, one each for two basins. A set of two microtubes taken from one distributor was used as dripper for one basin. The discharge from each dripper was about 2.5 lit/hr. The open ends of microtubes were kept at a height of about 15 cm above ground surface by tying to stakes fixed on the ground. Clogging caused by soil practicles was prevented by doing this. In order to increase or decrease the rate of flow the ends of microtubes were lowered or raised. After proper adjustment the microtubes were kept in a position and variation in the rate of discharge could be clearly seen when the ends were lowered or raised. Since the ends of microtubes were kept at a raised position, clogging was easily noticed and rectified then and there.

6. Variation of discharge through microtubes

The variation of discharge through microtubes could be achieved by

1. Raising or lowering the ends of microtubes fixed to the stakes.

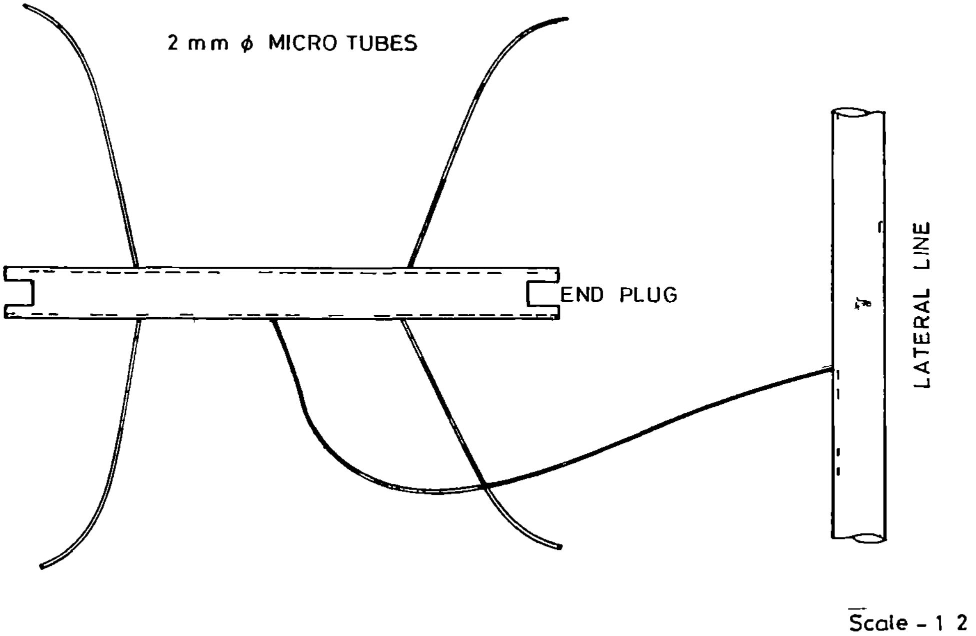


Fig 7 DISTRIBUTOR

Plate III   Drip irrigated cucumber plot

2. Varying the length of microtubes which changed head loss due to friction.
3. Changing the diameter of microtubes.
4. Raising or lowering the storage tank which varied the hydraulic head.

7. Economics

The cost of installation and operation of KAU drip irrigation system in one season per hectare was worked out. This was compared with the cost of installation and operation of conventional basin irrigation. Details are given in Appendices 17 and 18.

Results and Discussion

RESULTS AND DISCUSSION

A. Biometric observations

The biometric observations taken on the crops were (1) days to flower (2) fruits obtained during first and second harvest and the total number of fruits (3) fruit yield obtained during first and second harvest and the total fruit yield during the experiment.
The results of these observations are given in Tables 3 to 16. The results are represented diagramatically in Figures 8 to 21. Tables showing the analysis of variance are given as Appendices 3 to 16.

B. Ashgourd

1. Days to flower

Number of days taken for flowering did not show any significant difference between the treatments (Table 3, Fig.8, Appendix 3).

2. Number of fruits

There was significant difference between the treatments in number of fruits during first and second

Table 3. Days to flower in ashgourd

Treatments	Replications				
	R_1	R_2	R_3	R_4	Mean
T_1	52	50	54	51	51.8
T_2	51	50	52	53	51.5
T_3	51	54	48	50	50.8
T_4	52	51	51	52	51.5
T_5	53	53	52	48	51.5
T_6	51	54	53	51	52.3
SEm $\pm$					0.9
C.D. (0.05)					NS

T_1 Drip irrigation with IW/CPE = 1
T_2 Drip irrigation with IW/CPE = 0.7
T_3 Drip irrigation with IW/CPE = 0.4
T_4 Basin irrigation with IW/CPE = 1
T_5 Basin irrigation with IW/CPE = 0.7
T_6 Basin irrigation with IW/CPE = 0.4

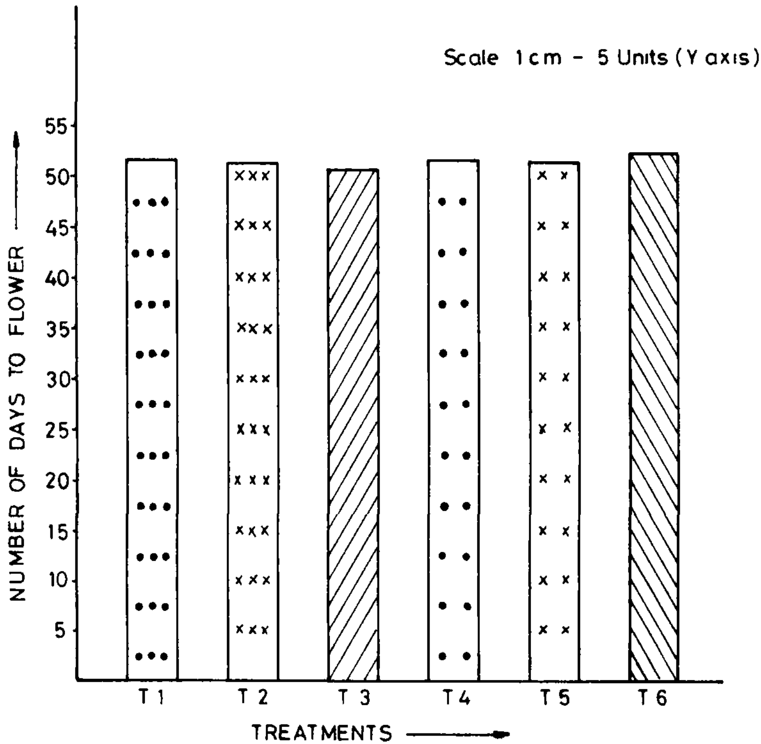


Fig 8 NUMBER OF DAYS TO FLOWER (ASHGOURD)

harvests. Statistical analysis on total number of fruits also showed significant difference between the treatments. Maximum number of fruits were obtained from treatments T_1, T_2 and T_4 (Tables 4, 5 and 6; Fig. 9, 10, 11; Appendices 4, 5 and 6). But T_2 which was on par with T_4, was given a lesser quantity of water. Hence by giving a smaller quantity of water in drip method, nearly the same number of fruits could be obtained as in T_4.

3. Fruit yield

The weight of fruit during the first harvest showed significant difference between the treatments. The treatments T_1, T_2 and T_4 were on par (Tables 7, 8, 9; Figs. 12, 13, 14; Appendices 7, 8 and 9). IW/CPE ratio was 1 for treatments T_1 and T_4 and for treatment T_2 it was 0.7. This means with 30 per cent less water in T_2 plot, we could achieve yield with cent per cent water in T_4 and T_1. Sheela (1988) did an experiment in the same field and found that the conveyance loss in the field was 27.7 per cent. Since T_2 was a drip irrigated plot, this conveyance loss was eliminated.

Table 4. Fruits/18 m^2 in ashgourd during 1st harvest

Treatments	Replications				Mean
	R_1	R_2	R_3	R_4	
T_1	11	9	11	10	10.3
T_2	9	7	11	8	8.8
T_3	7	5	2	3	4.3
T_4	8	10	8	10	9.0
T_5	7	7	5	11	7.5
T_6	5	4	3	3	3.8
SE m ±					0.9
C.D. (P = 0.05)					2.66

Table 5. Fruits/18 m^2 in ashgourd during 2nd harvest

Treatments	Replications				Mean
	R_1	R_2	R_3	R_4	
T_1	2	3	4	3	3.0
T_2	2	2	2	2	2.0
T_3	2	2	1	1	1.5
T_4	3	2	3	2	2.5
T_5	2	2	2	1	1.8
T_6	2	1	1	2	1.5
SEm $\pm$					0.3
CD (P = 0.05)					0.89

Table 6. Total fruits/$18m^2$ in ashgourd 1+2+3+4 Harvests

Treatments	Replications				Mean
	R_1	R_2	R_3	R_4	
T_1	14	13	16	14	14.3
T_2	12	10	13	11	11.5
T_3	9	8	3	5	6.3
T_4	12	12	12	13	12.3
T_5	9	10	8	13	10.0
T_6	8	5	5	6	6.0
SEm ±					0.9
CD (P = 0.05)					2.68

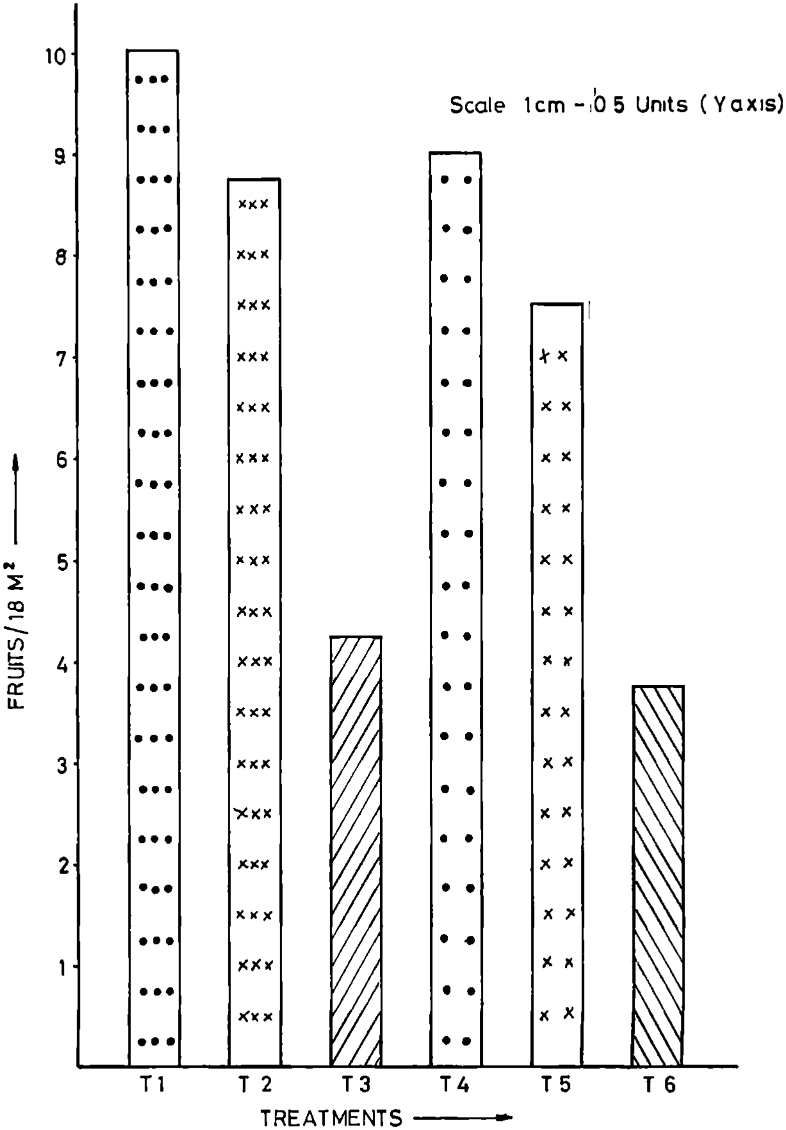


Fig 9 FRUITS OF ASHGOURD IN FIRST HARVEST (NUMBER / 18 M^2)

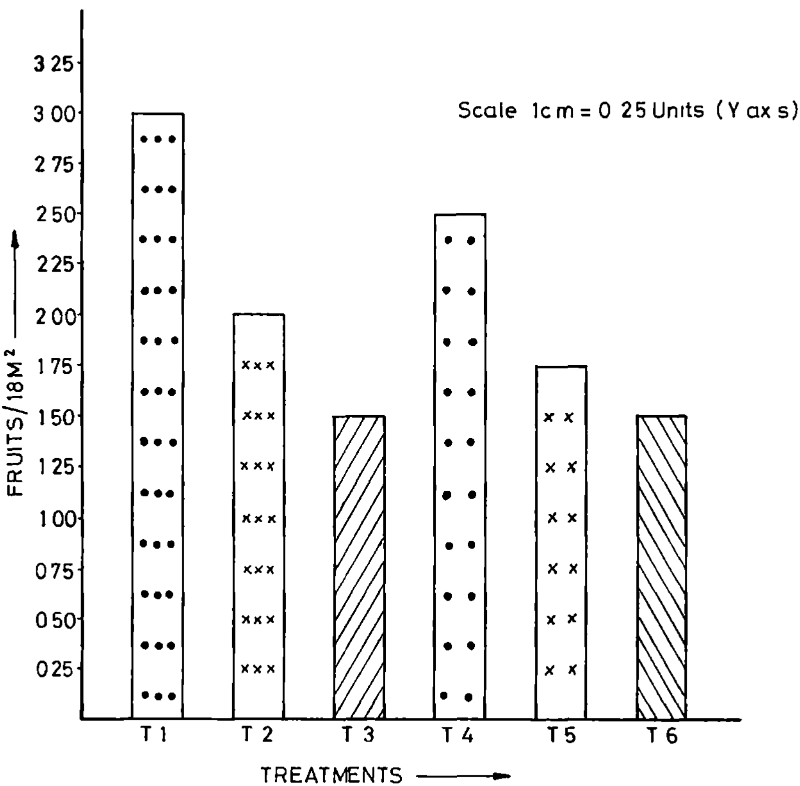


Fig 10 FRUITS OF ASHGOURD IN SECOND HARVEST (NUMBER / 18 M^2)

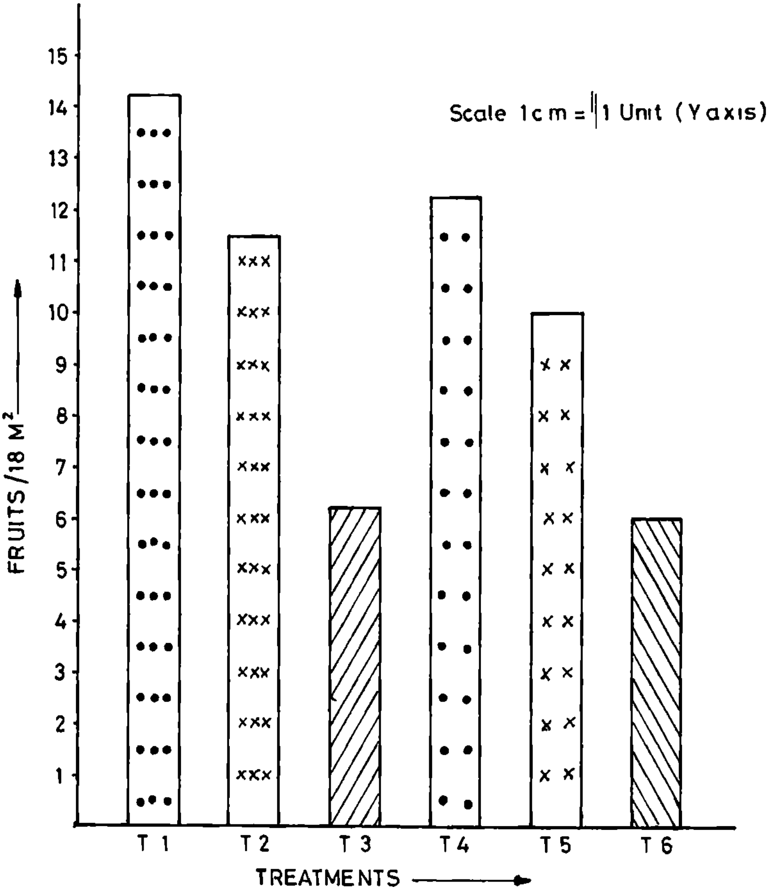


Fig 11 TOTAL NUMBER OF FRUITS IN ASHGOURD
(NUMBER/18 M^2) 1+2+3+4 HARVES S

Table 7. Fruit yield/18 m^2 in ashgourd during 1st harvest

Treatments	Replications				Mean
	R_1	R_2	R_3	R_4	
T_1	43.8	31.8	33.8	34.5	35.98
T_2	33.8	30.6	38.6	28.8	32.95
T_3	20.0	14.8	5.2	8.1	12.03
T_4	38.8	30.8	27.8	32.6	32.50
T_5	26.8	21.0	20.6	36.8	26.30
T_6	19.8	10.4	7.8	10.6	12.15
SEm ±					2.4
C.D. (P = 0.05)					7.28

Table 8. Fruit yield/18 m^2 in ashgourd durina 2nd harvest

Treatments	Replications				Mean
	R_1	R_2	R_3	R_4	
T_1	8.0	6.8	7.6	7.2	7.40
T_2	7.0	6.4	6.8	7.6	6.95
T_3	3.8	3.6	2.6	3.8	3.45
T_4	8.8	5.6	8.8	5.4	7.15
T_5	5.2	7.0	6.2	5.0	5.85
T_6	4.2	2.6	3.2	3.2	3.30
SEm ±					3.63
C.D.(P = 0.05)					NS

Table 9. Total fruit yield/18 m^2 in ashgourd 1+2+3+4 Harvests

Treatments	Replications				Mean
	R_1	R_2	R_3	R_4	
T_1	55.8	42.1	45.0	44.9	46.95
T_2	42.8	40.0	45.4	40.0	42.05
T_3	23.8	20.4	7.8	14.1	16.53
T_4	51.4	36.4	39.8	41.4	42.25
T_5	32.0	32.0	30.2	45.4	34.90
T_6	25.3	13.0	12.8	15.6	16.68
SEm ±					2.56
C.D.(P = 0.05)					7.71

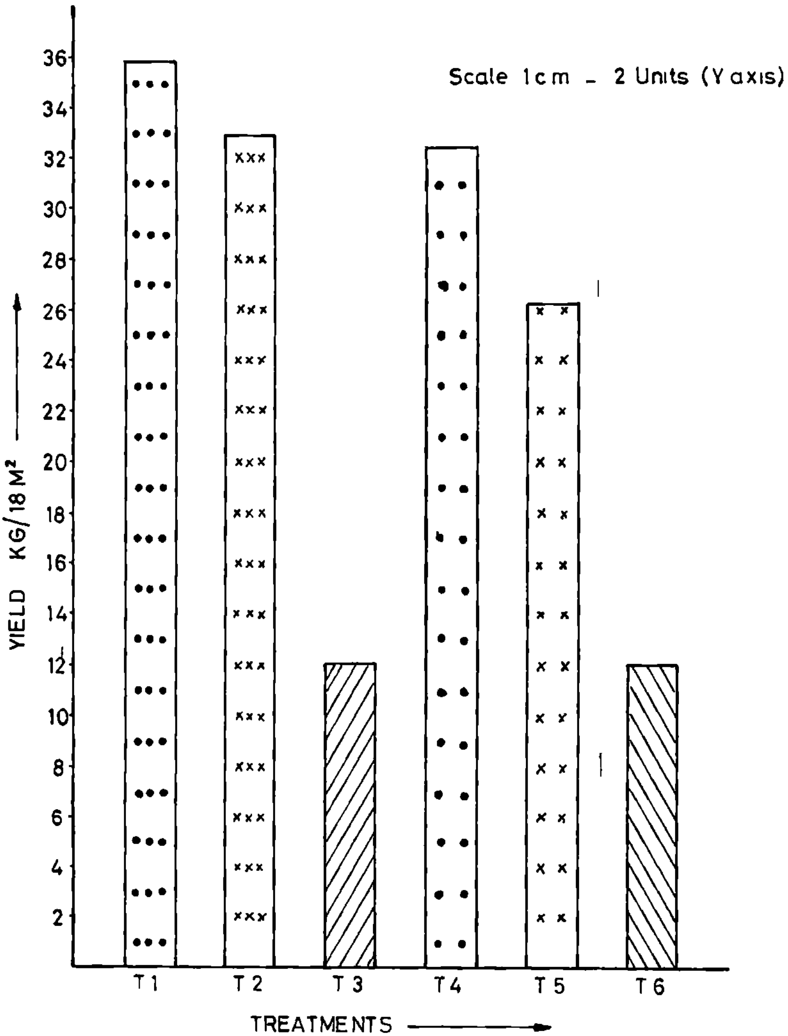


Fig 12 YIELD OF ASHGOURD IN FIRST HARVEST ($KG/18 M^2$)

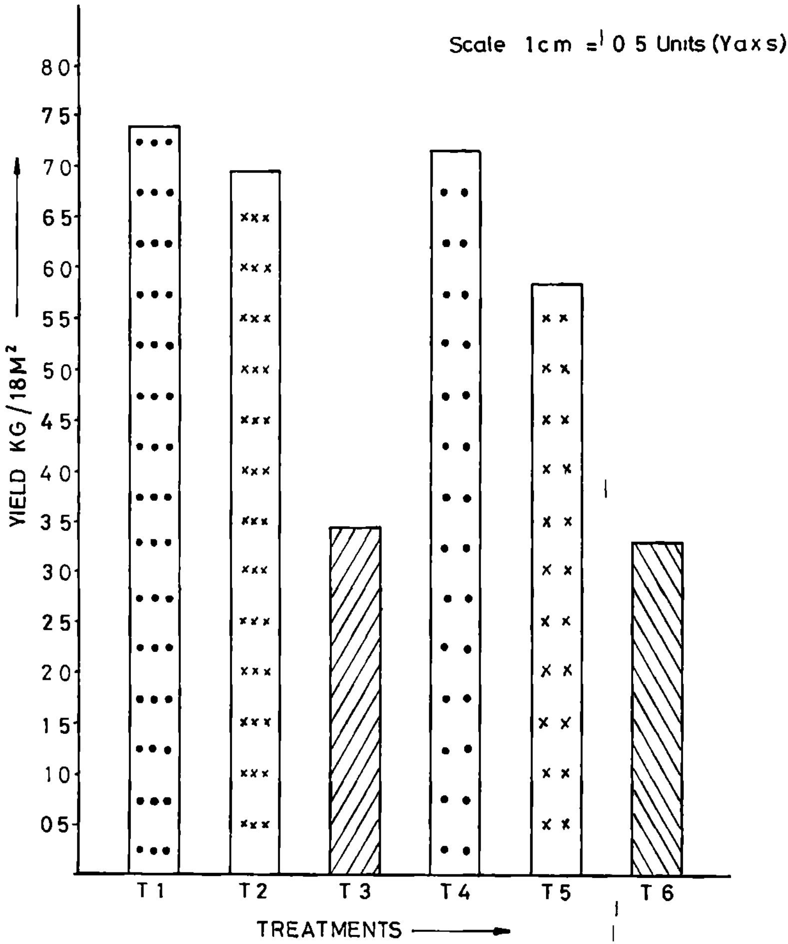


Fig 13 YIELD OF ASHGOURD IN SECOND HARVEST (KG/18 M²)

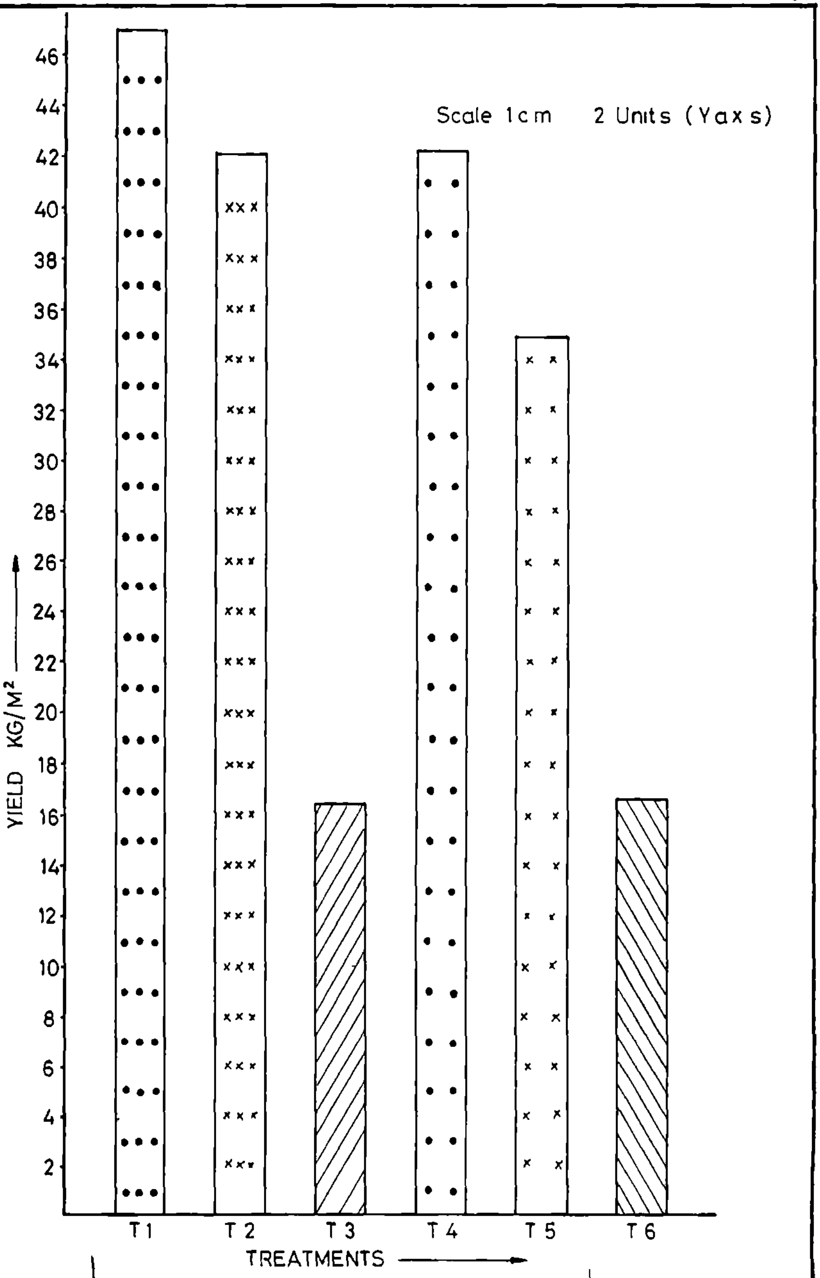


Fig 14 TOTAL YIELD OF ASHGOURD (KG/18 M^2) +2+3 4 HAR ESTS

The weight of fruit obtained during second harvest did not show any significant difference between the treatments. The fruits obtained during second harvest got a considerable amount of rain during their fruit development stage. This may be the reason for not obtaining a significant difference between treatments.

Statistical analysis on the total yield, during the crop period showed significant difference between treatments. Treatments T_1, T_2 and T_4 were on par. The IW/CPE ratio was 1 for treatments T_1 and T_4 and it was 0.7 for treatment T_2. Hence 30% less water was needed to produce the same yield as in treatment T_4. As stated earlier there was a conveyance loss of 27.7% in this experimental field. This water also could be saved in treatment T_2, since it was drip irrigated. Here we see that considerable amount of water was saved in drip method T_2. This means we can utilise our limitted sources of water supply in a better way and bring more area under irrigation using drip method.

In this experiment we find that the optimum value of IW/CPE ratio for ashgourd is 0.7 in drip method and 1 in basin method.

C. Cucumber

1. Days to flower

There was no significant difference between the treatments regarding the number of days taken for flowering (Table 10, Fig. 15, Appendix, 10).

2. Number of fruits

The number of fruits during first harvest showed significant difference between the treatments (Tables 11, 12, 13; Figs. 16, 17, 18; Appendices 11, 12, 13). Treatments T_1, T_2, T_4 and T_5 were on par. Treatments T_2 and T_5 were given less amount of water than T_1 and T_4. The conveyance loss in the field was found to be 27.7% while Sheela (1988) did an experiment in the same field. Treatments T_2 and T_5 were given same amount of water. But conveyance loss was eliminated in Treatment T_2, because it was drip irrigated.

There was no significant difference between treatments during second harvest.

The total number of fruits showed significant difference between treatments. Treatments T_1, T_2, T_4

Table 10. Days to flower in cucumber

Treatments	Replications				Mean
	R_1	R_2	R_3	R_4	
T_1	33	35	35	35	34.5
T_2	35	33	36	37	35.3
T_3	36	29	36	35	34.0
T_4	33	31	32	36	33.0
T_5	33	35	35	37	35.0
T_6	35	36	39	39	37.3
SEm $\pm$					4.6
C.D. ($P = 0.05$)					NS

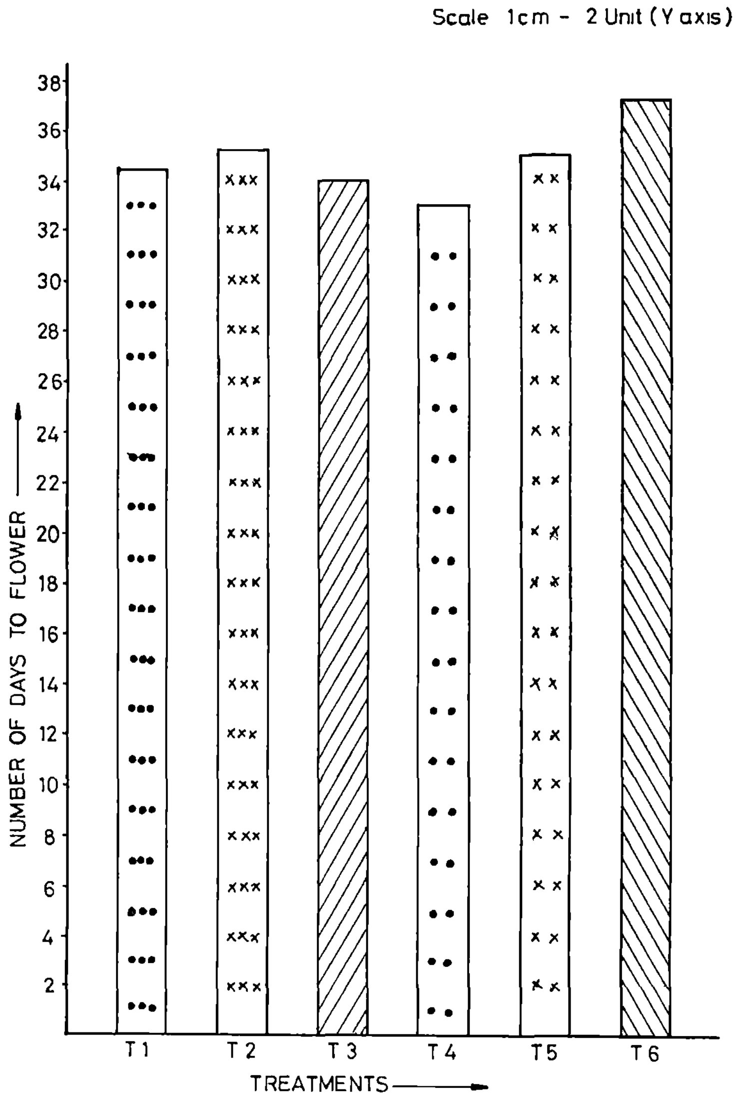


Fig 15 NUMBER OF DAYS TO FLOWER (CUCUMBER)

Table 11. Fruits/18 m^2 in cucumber during 1st harvest

Treatments	Replications				Mean
	R_1	R_2	R_3	R_4	
T_1	17	19	15	17	17.00
T_2	13	11	11	20	13.75
T_3	13	7	5	7	8.00
T_4	17	16	13	9	13.75
T_5	14	17	14	5	12.50
T_6	9	4	3	4	5.0
SEm ±					1.76
C.D. (P = 0.05)					5.3

Table 12. Fruits/18 m^2 in cucumber during 2nd harvest

Treatments	Replications				Mean
	R_1	R_2	R_3	R_4	
T_1	9	12	13	8	10.5
T_2	8	15	8	10	10.3
T_3	12	5	10	10	9.3
T_4	11	10	16	10	11.8
T_5	18	9	8	7	10.5
T_6	3	8	6	8	6.3
SEm ±					1.77
C.D. (P = 0.05)					5.33

Table 13. Total fruits/18 m^2 in cucumber 1+2+3+4 Harvests

Treatments	Replications				Mean
	R_1	R_2	R_3	R_4	
T_1	32	43	39	32	36.5
T_2	29	36	26	39	32.5
T_3	25	20	19	23	21.8
T_4	35	41	38	27	35.3
T_5	41	35	32	19	31.8
T_6	20	16	15	18	17.3
SEm ±					2.88
C.D. (P = 0.05)					8.67

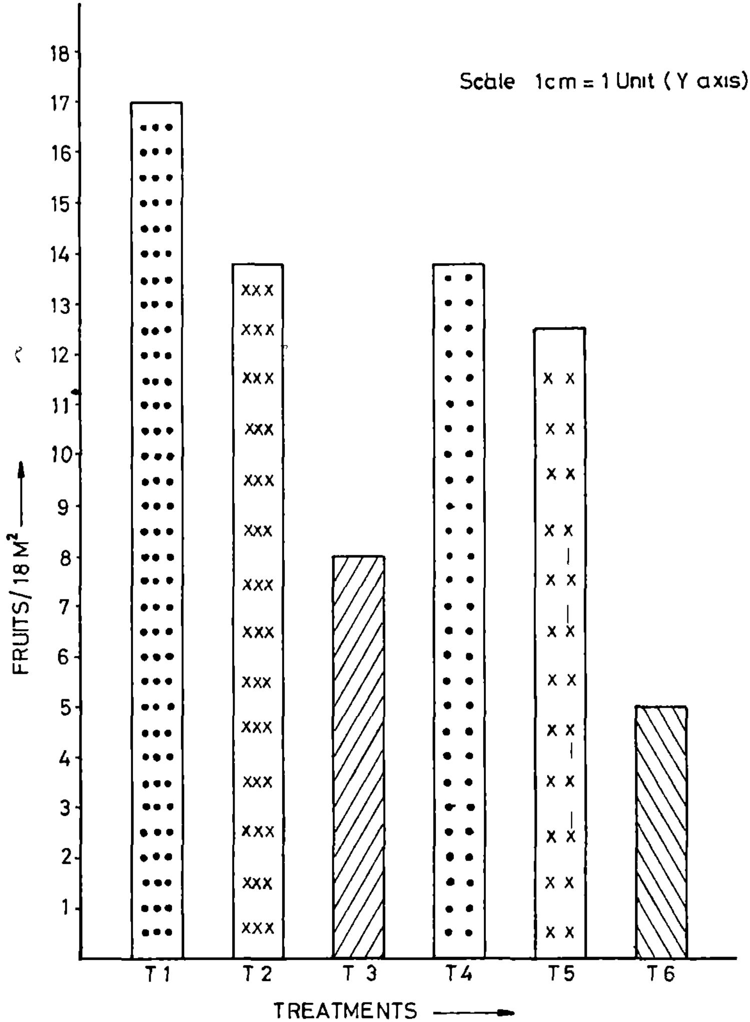


Fig 16 FRUITS OF CUCUMBER IN FIRST HARVEST (NUMBER/18 M^2)

Scale 1 cm 1 Unit (Y axis)

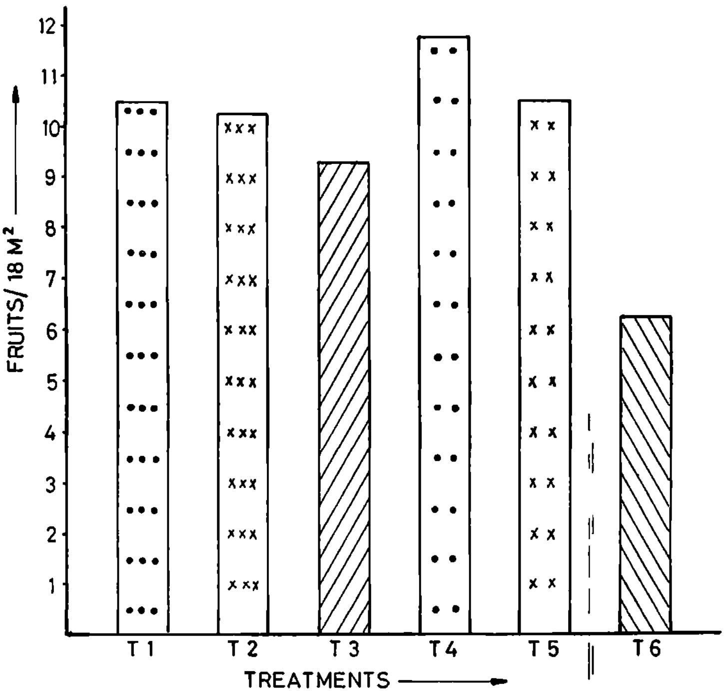


Fig 17 FRUITS OF CUCUMBER IN SECOND HARVEST (NUMBER / 18 M^2)

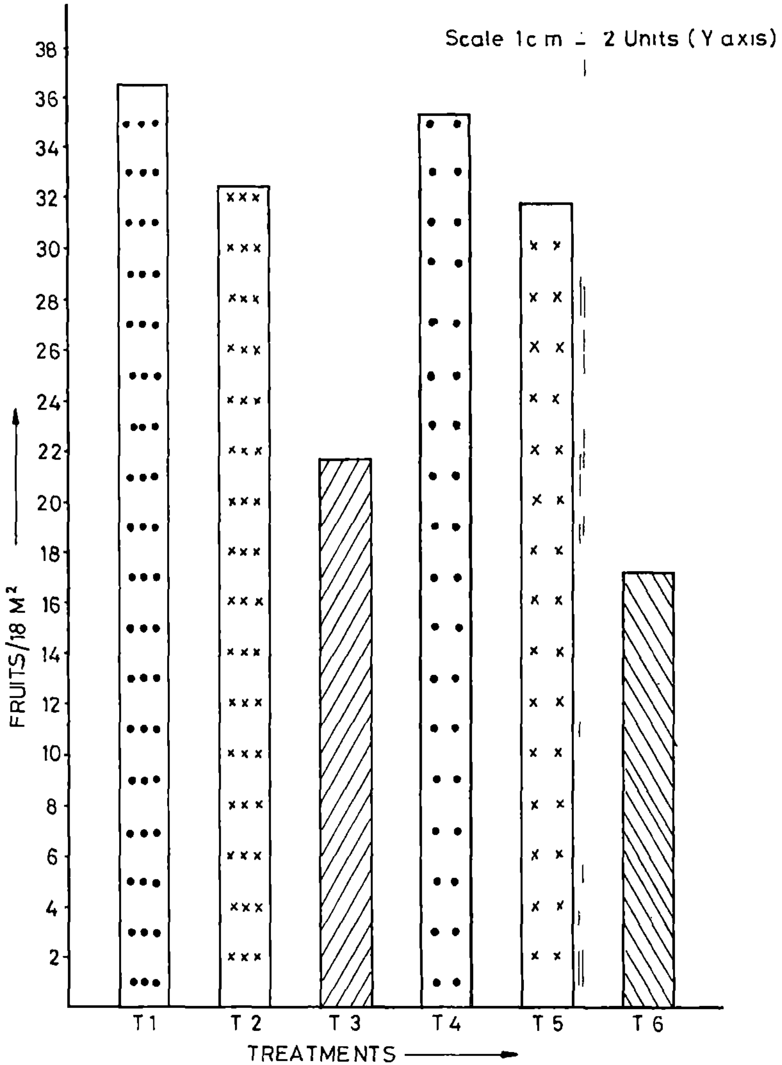


Fig 18 TOTAL NUMBER OF FRUITS IN CUCUMBER (NUMBER/18 M^2) 1+2 3 4 HARVES S

and T_5 were on par. Treatments T_2 and T_5 were given lesser amount of water than T_1 and T_4. Though T_2 and T_5 were irrigated with same quantity of water, a conveyance loss of 27.7% was eliminated in the case of treatment T_2.

3, Fruit yield

The statistical analysis on the weight of fruit showed significant difference between treatments during first and second harvests (Tables 14, 15, 16; Figs. 19, 20, 21; Appendices 14, 15, 16). The treatments T_1, T_2, T_4 and T_5 were on par. IW/CPE ratio was 1 for T_1 and T_4 and it was 0.7 for T_2 and T_5. In T_2 and T_5 30% less water was needed to get the same yield as in T_1 and T_4. Treatment T_2 was drip irrigated and treatment T_5, basin irrigated. As stated earlier there was additional conveyance loss of 27.7% in basin irrigated plot. This loss was eliminated in treatment T_2, since it was drip irrigated plot.

The total fruit weight also showed significant difference between treatments, on statistical analysis. Treatments T_2 and T_4 were on par. In the drip method T.

Table 14. Fruit yield/18 m^2 in cucumber during 1st harvest

Treatments	Replications				Mean
	R_1	R_2	R_3	R_4	
T_1	19.0	24.4	13.8	13.0	17.55
T_2	15.2	7.2	11.4	15.0	12.20
T_3	14.2	6.6	5.0	4.0	7.45
T_4	17.4	20.2	14.4	13.0	16.25
T_5	16.0	16.6	13.8	3.4	12.45
T_6	8.8	4.4	3.0	2.0	4.55
SEm ±					1.82
C.D. (P = 0.05)					5.5

Table 15. Fruit yield/18 m^2 in cucumber during 2nd harvest

Treatments	Replications				Mean
	R_1	R_2	R_3	R_4	
T_1	11.8	12.8	10.2	8.2	10.75
T_2	9.8	15.6	7.6	7.8	10.20
T_3	9.4	5.6	7.6	6.6	7.30
T_4	11.0	8.8	10.8	9.2	9.95
T_5	10.8	9.0	6.0	6.0	7.95
T_6	2.6	8.2	5.6	4.2	5.15
SEm $\pm$					1.06
C.D. ($P = 0.05$)					3.19

Table 16. Total fruit yield/18 m^2 in cucumber 1+2+3+4 Harvests

Treatments	Replications				Mean
	R_1	R_2	R_3	R_4	
T_1	37.0	46.8	32.4	28.0	35.05
T_2	33.4	29.6	25.4	30.2	29.65
T_3	23.6	17.2	14.0	14.8	17.40
T_4	34.6	41.2	31.8	27.2	33.70
T_5	32.8	33.6	28.0	14.4	27.20
T_6	15.6	15.0	12.8	10.2	13.40
SEm ±					2.08
C.D. (P = 0.05)					6.26

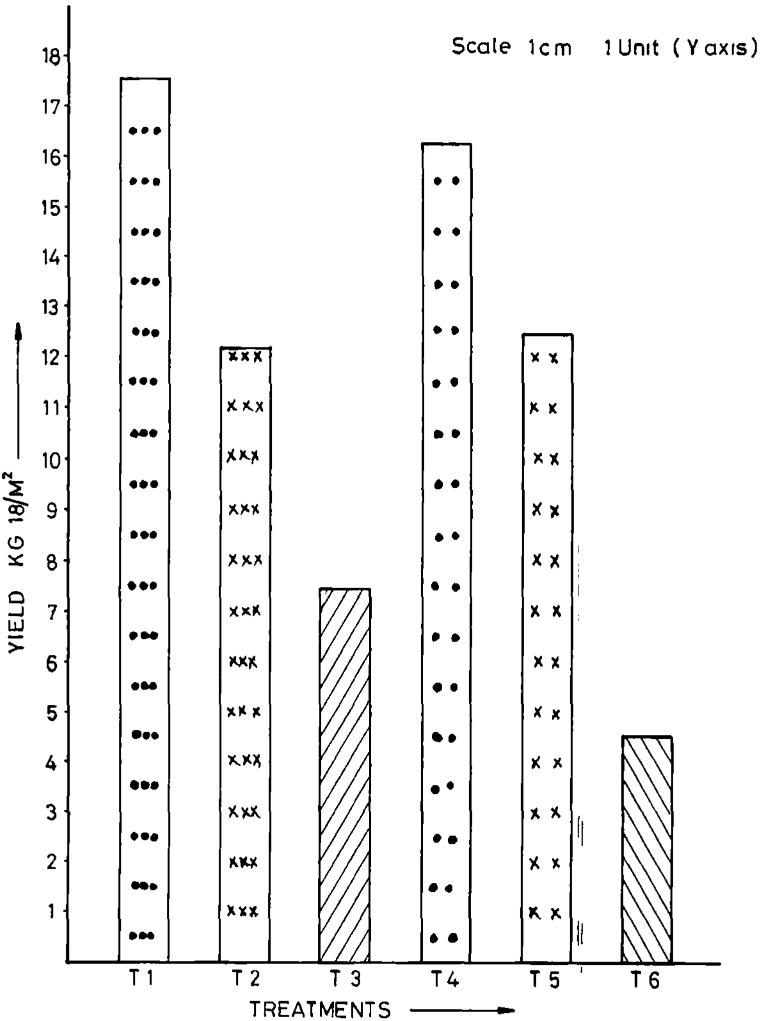


Fig 19 YIELD OF CUCUMBER IN FIRST HARVEST (KG/18M²)

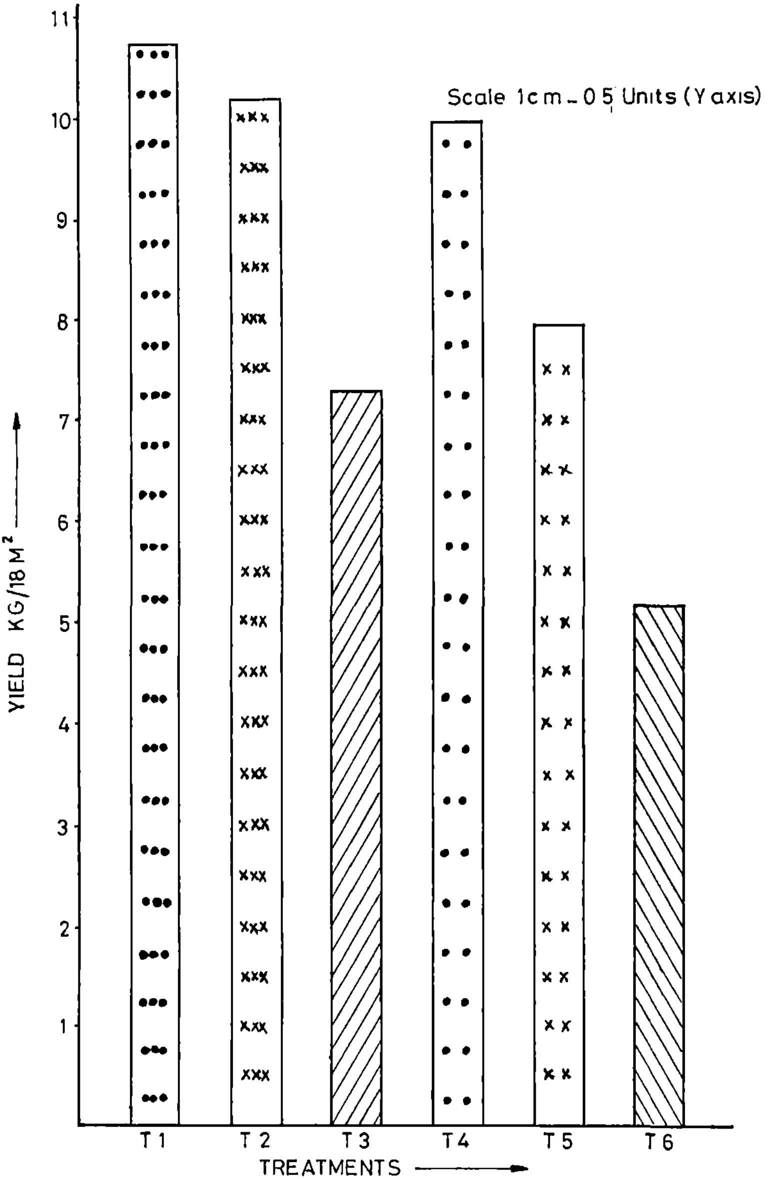


Fig 20 YIELD OF CUCUMBER IN SECOND HARVEST (KG/M²)

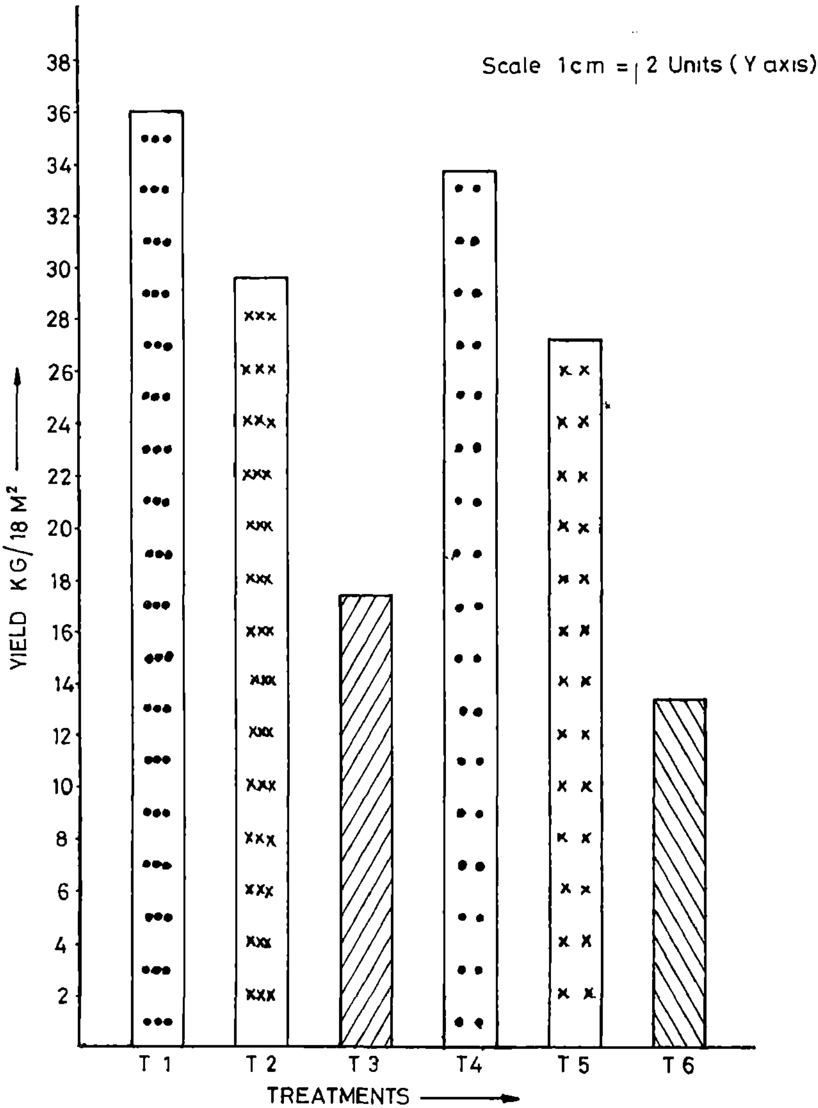


Fig 21 TOTAL YIELD OF CUCUMBER (KG/18M²)

1+2 3+4 HARVESTS

was superior to T_5. In the case of cucumber the optimum value of IW/CPE ratio is found to be 1. But in drip method the conveyance loss was practically nil. In basin irrigated experimental field, the conveyance loss was found to be 27.7 per cent. This amount of water could be saved using drip method and utilised for bringing more area under irrigation. Hence the drip method is preferred in cases where there is water scarcity, especially in dry season.

The experimental results during 1981-82 revealed that response of ashgourd to different methods of irrigation was not significant. The interaction between levels and methods of irrigation was significant (Anon, 1981-82). Work done by Koshy Varghese at Kerala Agricultural University (1985) showed that there was no significant difference in the yield of banana under drip and basin methods of irrigation. According to Sheela (1988), brinjal yield showed significant difference between the drip method and the basin method and the treatment which received minimum quantity of water in drip method was significantly superior to treatment T_4 which received maximum quantity of water in basin method of irrigation.

The statistical analysis on yield of Amaranthus also showed significant difference between treatments. Maximum yield was obtained from treatment T_1, which received maximum quantity of water in drip method. Treatment T_3 which received minimum quantity of water in drip method was significantly superior to treatment T_4 which received maximum quantity of water in basin method of irrigation.

D. Special features of KAU drip system

1. The system works on very low pressure. Hence the pipes and fittings for the system last longer.

2. The materials required for the installation of the system are locally available.

3. Defects can be rectified within the field itself.

4. In this system clogging is not a serious problem.

5. Skilled labour is not required for the fabrication and installation of the system. The operation of the system is so simple that any person can do it.

6. Since the system is cheaper it can be economically installed in small farms.

7. As the system works on low pressure, this can cover only a small area. If the pressure is increased it will cause leaks at joints. This is the limitation of KAU drip irrigation system.

E. Special points noted during the experiment

Clogging occurred in the first 2-3 days. This was rectified by gently sucking the microtubes or by tapping the tubes. Once the clogging problem was rectified, the drip irrigation system worked well throughout the irrigation time.

Weed growth is not a serious problem for the crops like ashgourd and cucumber. The weed growth was less in the drip irrigated plots.

The materials used for the fabrication of the system were purchased locally. Filter units were eliminated in this system. The installation of the system was done by ordinary labourers. No adheseive was required as this system worked on low pressure and the microtubes were connected by the push fit method. Since the pressure was low no leak was seen in these joints.

In the conventional method of irrigation, a large quantity of water is lost from field channels due to evaporation and deep percolation. This was completely eliminated in the drip system of irrigation.

From the results it was seen that with a lesser quantity of water in drip method, a better yield could be obtained, than from the basin method. And also there was considerable water saving in drip method since field channels were eliminated. Hence the water which is t nature's boon to man, could be utilised in a better way and could be used to irrigate more area.

Since only a measured quantity of water was applied, loss due to deep percolation was minimised. The drip method of orrigation restricted the water within the root zone area and hence the surface area from which evaporation could occur was also minimised.

Practically no conveyance loss occurred in drip method during the experiment.

By the drip method it becomes possible for daily maintenance of an adequate section of the root zone of a plant at near field capacity during the growing and productive cycle. Limited source of water supply from small ditches and tanks can be utilised for this and a rather high moisture regime prevails within the quite sharply defined boundaries of the wetted bulb which enables the development of live roots.

F. Effect of rain

There was rainfall on some days during the experiment. Irrigation was done after considering the amount of rainfall. Drip and basin methods gave nearly the same yield in both ashgourd and cucumber. But conveyance loss was practically nil in the case of drip irrigation. Hence it could be preferred over basin irrigation. If the interaction of rain was not present, drip method could have given a better yield.

G. Economics

The cost of installation and operation of KAU drip irrigation system in one season per hectare of ashgourd was found to be Rs. 2045/=. But the cost of installation and operation of conventional basin irrigation system was Rs.3150/=. Rs. 1105/= could be saved in drip method in one season using drip method.

Summary

SUMMARY

Irrigation is the artificial application of water to soil for the purpose of crop production. In many areas of the world the amount and timing of rainfall are not adequate to meet the moisture requirement of crops. Scientific management of irrigation water provides the best insurance against weather-induced fluctuations in total food production. Efficient utilization of the limited water resources for crop production is of prime importance, since this limited water should also meet the requirements of growing industry, human and livestock consumption, recreation, navigation, Hence scientists are looking for new techniques for the efficient utilization of water. In this context, drip irrigation becomes very important.

In drip irrigation, plants are irrigated frequently with a volume of water equal to the consumptive use of plants and this water is delivered in drops at the soil surface near the base of plants. The frequent application of water keeps the soil always at the optimum condition of moisture for plant growth. The system minimises losses due to evaporation and deep percolation.

The relative efficiency evaluation of drip and basin methods of irrigation were carried out under field conditions at varying levels of water supply in ashgourd and cucumber. The experiment was laid out in a randomised block design. There were 6 treatments and 4 replications. The spacing of the plants was 4.5 m x 2 m. Each plot was surrounded by bunds. There were 4 pits in a plot, one at each corner. There were two plants in one pit. All the plants were treated as experimental plants.

The drip irrigation system was fabricated using locally available materials. Oil drums of 200 l capacity were used as storage tanks for the system. 25 mm and 12 mm black polyethylene pipes were used for main and lateral lines respectively. Commercially available Tee joints were used for connecting lateral to main.

Mictoubes of 2 mm diameter were used as drippers or emitters. The microtubes were connected to the laterals by making holes having slightly lesser diameter than the external diameter of the micro tubes and pushing the microtubes into these holes for a tight fit. These joints were leak proof as the system worked on low pressure.

The microtube attached to the lateral was connected to a distributor and it was the 'heart' of this drip irrigation system. The distributor was developed at the Agronomic Research Station, Chalakudy in the year 1977. Four microtube emitters were connected to the distributor. The distributor reduced the discharge per emitter to about 1 to 5 litres per hour.

The tips of the microtube emitters were kept raised about 20 cm above the ground surface by tying to states fixed on the ground. The discharge from the microtubes could be varied by (1) changing the length of microtubes (2) raising or lowering the microtube tips on the stakes (3) changing the diameter of the microtubes (4) varying the hydraulic head.

Irrigation schedule was based on IW/CPE ratios. In drip method and basin method IW/CPE ratios of 1, 0.7 and 0.4 were taken. In drip method, irrigation was done every day. Depth of irrigation water was based on the pan evaporation value of the previous day.

In basin method, the depth of irrigation water was 30 mm and frequency of irrigation was based on pan evaporation values and IW/CPE ratios. In basin method circular orifice plates were used in the sub channel to measure the flow of irrigation water.

Statistical analysis on the total yield of ashgourd showed significant difference between treatments. Treatments T_1, T_2 and T_4 were on par. The IW/CPE ratio was 1 for T_1 and T_4 and 0.7 for T_2. Hence 30% less water was needed to produce the same yield as in treatment T_4. There was a conveyance loss of 27.7% in this experimental field. This water also could be saved in treatment T_2, since it was drip irrigated. The optimum value of IW/CPE ratio for ashgourd was found as 0.7 in drip method and 1 in basin method.

Statistical analysis on the total yield of cucumber also showed significant difference between treatments. Treatments T_1 and T_4 were on par. In the drip method T_1 was superior to T_2. In the basin method T_4 was superior to T_5. In the case of cucumber the optimum value of IW/CPE ratio was found to be 1. But in drip method the conveyance loss was practically nil. The amount of water saved by eliminating the conveyance loss can be utilised for bringing more area under irrigation.

The number of days taken for flowering did not show any significant difference between treatments, in both the crops. But the total number of fruits showed significant difference between treatments in both the cases

Installation of KAU drip irrigation system was simple and no special skill was required for the fabrication and operation. All the materials were readily available. Faults were rectified in the field itself. Clogging was not a serious problem in this system. As the system worked on low pressure, the pipes and tubes could last longer than in the case of conventional system.

The cost of installation and operation of KAU drip irrigation system and conventional basin irrigation system were worked out for the crop ashgourd and it was found that Rs. 1105/= could be saved per hectare in one season by adopting drip method of irrigation.

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Appendices

Appendix 1. Time required for the flow of 270 litres of water through the 7.5 cm diameter orifice

Head of water over centre of orifice (cm)	Discharge l/Sec.	Time required to flow 270 l in seconds
1.0	1.2	225.00
1.5	1.4	192.86
2.0	1.7	158.82
2.5	1.8	150.00
3.0	2.1	128.57
3.5	2.2	122.73
4.0	2.4	112.50
4.5	2.5	108.00
5.0	2.7	100.00
5.5	2.8	96.43
6.0	2.9	93.10
6.5	3.0	90.00
7.0	3.1	87.10
7.5	3.3	81.82
8.0	3.4	79.41
8.5	3.5	77.14
9.0	3.6	75.00
9.5	3.7	72.97
10.0	3.8	71.05

Appendix 2. Time required for the flow of 270 litres of water through the 5 cm diameter orifice

Head of water over centre of orifice (cm)	Discharge 1/Sec.	Time required to flow 270 1 (in seconds)
1.0	0.53	509.43
1.5	0.64	421.88
2.0	0.74	364.86
2.5	0.81	333.33
3.0	0.91	296.70
3.5	0.99	272.73
4.0	1.15	234.78
4.5	1.20	225.00
5.0	1.21	223.14
5.5	1.23	219.51
6.0	1.30	207.69
6.5	1.34	201.49
7.0	1.39	194.24
7.5	1.45	186.21
8.0	1.50	180.00
8.5	1.53	176.47
9.0	1.60	168.75
9.5	1.62	166.67
10.0	1.70	158.82

Appendix 3. General analysis of variance for days to flower in ashgourd

Sources	df	S.S.	M.S	F value
Treatments	5	4.71	0.942	0.26[NS]
Blocks	3	4.46	1.487	
Error	15	52.79	3.520	
Total	23	61.96		

NS = Not significant

Appendix 4. General analysis of variance for fruits/18 m^2 in ashgourd during first harvest

Sources	df	S.S.	M.S.	F value
Treatments	5	142.50	28.50	9*
Blocks	3	4.83	1.61	
Error	15	47.17	3.14	
Total	23	194.50		

*P = 0.05

Appendix 5. General analysis of variance for fruits/ 18 m^2 in ashgourd during second harvest

Sources	df	S.S.	M.S.	F value
Treatments	5	7.21	1.442	4.12*
Blocks	3	0.46	0.15	
Error	15	5.29	0.35	
Total	23	12.96		

*P = 0.05

Appendix 6. General analysis of variance for total fruits/18 m^2 in ashgourd

Sources	df	S.S.	M.S.	F value
Treatments	5	221.71	44.34	13.9*
Blocks	3	5.46	1.82	
Error	15	42.79	3.186	
Total	23	274.96		

*P = 0.05

Appendix 7. General analysis of variance for fruit yield/18 m^2 in ashgourd during 1st harvest

Sources	df	S.S.	M.S.	F value
Treatments	5	2297.86	459.572	19.63*
Blocks	3	241.88		
Error	15	351.03	23.402	
Total	23	2890.97		

*P = 0.05

Appendix 8. General analysis of variance for fruit yield/18 m^2 in ashgourd during 2nd harvest

Sources	df	S.S.	M.S.	F value
Treatments	5	69.60	13.92	0.26 (NS)
Blocks	3	2.95	0.98	
Error	15	789.61	52.64	
Total	23	862.16		

Appendix 9. General analysis of variance for total fruit yield/18 m2 in ashgourd

Sources	df	S.S.	M.S.	F value
Treatments	5	3616.53	723.306	27.6*
Blocks	3	263.56	87.850	
Error	15	392.61	26.174	
Total	23	4272.70		

*P = 0.05

Appendix 10. General analysis of variance for days to flower in cucumber

Sources	df	S.S.	M.S.	F value
Treatments	5	40.83	8.166	0.097 (NS)
Blocks	3	38.66	12.890	
Error	15	1266.84	84.460	
Total	23	1346.33		

Appendix 11. General analysis of variance for fruits/18 m^2 in cucumber during 1st harvest

Sources	df	S.S.	M.S.	F value
Treatments	5	382.83	76.57	6.19*
Blocks	3	55.00		
Error	15	185.50	12.37	
Total	23	623.33		

* P = 0.05

Appendix 12. General analysis of variance for fruits/18 m^2 in cucumber during 2nd harvest

Sources	df	S.S.	M.S.	F value
Treatments	5	71.50	14.3	1.14 (NS)
Blocks	3	7.17		
Error	15	187.83	12.52	
Total	23	266.50		

Appendix 13. General analysis of variance for total fruits/18 m^2 in cucumber

Sources	df	S.S.	M.S.	F value
Treatments	5	1222.33	244.47	7.36*
Blocks	3	105.00		
Error	15	498.00	33.20	
Total	23	1825.33		

* P = 0.05

Appendix 14. General analysis of variance for fruit yield/18 m^2 in cucumber during 1st harvest

Sources	df	S.S.	M.S.	F value
Treatments	5	496.78	99.356	7.47*
Blocks	3	162.27	54.09	
Error	15	199.61	13.3	
Total	23	858.66		

* P = 0.05

Appendix 15. General analysis of variance for fruit yield/18 m^2 in cucumber during 2nd harvest

Sources	df	S.S.	M.S.	F value
Treatments	5	92.02	18.404	4.09*
Blocks	3	31.87		
Error	15	67.41	4.494	
Total	23	191.30		

* P = 0.05

Appendix 16. General analysis of variance for total fruit yield/18 m^2 in cucumber

Sources	df	S.S.	M.S.	F value
Treatments	5	1629.80	325.96	18.8*
Blocks	3	381.99		
Error	15	259.55	17.30	
Total	23	2271.34		

* P = 0.05

Appendix 17

Cost of installing KAU drip irrigation system for ashgourd in one season/hectare (Rs.)

Items	Qty.	Unit	Rate	Amount
1. Main line 50 mm black polyethylene pipe	100	Metre	18.00	1800.00
2. Lateral line 12 mm black polyethylene pipe	1100	Metre	2.00	2200.00
3. G.I.Tee 50 mm x 12 mm	11	Nos.	30.00	330.00
4. Wheel valve 50 mm	1	Nos.	200.00	200.00
5. Distributor (12 mm polythylene pipes)	82.5	Metres	2.00	165.00
6. Microtubes (2 mm dia)	4000	Metres	0.65	2600.00
7. Laying cost	8 labourers	No.	36.00	280.00
8. Miscellaneous expenses				600.00
				8175.00
Cost of tank for 60 m^3 capacity (Masonry)				7000.00
		Total		15175.00

Reasonable life period of materials like pipe, tees, etc. is 8 years. The depreciation on these items will be $\frac{8175}{8}$ = 1022 per year. The salvage value of these materials at the end of 8 years will be practically insignificant and hence ignored. Assuming that the life of masenry tank is 20 years, the depreciation will be Rs.350/=

per year. Interest on the undepreciated capital at the rate of 11% for the total amount of 15175 will be 1669.25.

Once the system is laid out, practically no labour is required to operate the system. However, for supervision pumping water into the tank and removal of clogging, about one hours work will be required per day. For an irrigation season of 120 days, 120 man hours will be required. This is approximately equal to 15 man days, which will involve a recurring expenditure of Rs.525/= per year.

Fixed cost for one season (considering 2 irrigation seasons in a year)

1. Depreciation of pipes, Tees etc.	Rs. $\frac{1022}{2}$	=	511.00
2. Depreciation of tank	Rs. $\frac{350}{2}$	=	175.00
3. Interest on capital	Rs. $\frac{1669}{2}$	=	834.50
			1520.50

<u>Variable cost</u>

1. Labour for operating the system	Rs. 525.00
Total operating cost	Rs. 2045.50

Appendix 18

Cost of irrigating one hectare of ashgourd by basin method in one season

About 50 labourers will be required to layout the irrigation channels and basins in one hectare. Two persons can irrigate one hectare. If the irrigation schedule is once in 6 days, for an irrigation season of 120 days, 20 irrigations will be required. The details cost for irrigating one hectare of ashgourd by basin method is given below.

1.	Number of labourers required for the layout of channels and basins	50
2.	Number of persons required for irrigating the basin, during one irrigation season	40
3.	Total number of labourers required	90
4.	Cost at the rate of Rs.35/- per labour	3150.00

The fixed and variable costs involved in operation of the pumping system has not been taken into account while calculating the above operating costs as this is common to both the methods.

RELATIVE EFFICIENCY EVALUATION OF DRIP AND CONVENTIONAL METHODS OF IRRIGATION IN ASHGOURD AND CUCUMBER

By

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ABSTRACT OF A THESIS

Submitted in partial fulfilment of the requirement for the degree

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ABSTRACT

Water, being a limited resource, its efficient use is very vital for the survival of the ever increasing population. As the availability of water being limited for irrigation purpose, the efficiency of utilisation of water has to be increased by adopting modern methods of irrigation. Drip irrigation is a promising technique for providing precise quantity of water without wastage. Though this method was started decades back, it has not become popular in our country.

The relative efficiency evaluation of a low cost drip irrigation system fabricated with locally available materials and the conventional basin method of irrigation was done in this experiment taking ashgourd and cucumber as indicating crops. In drip as well as the basin method the irrigation schedule was based on IW/CPE ratios of 1, 0.7 and 0.4. In drip method, plots were irrigated every day and the depth of irrigation water given was based on the pan evaporation value of the previous day. In the basin method, the depth of irrigation water given was 30 mm.

Oil drums of 200 litres capacity were used as the storage tanks for the drip irrigation system. 25 mm and 12 mm diameter black polyethylene pipes were used for main and lateral lines respectively. Main and laterals were connected by using commercially available 'Tee's.

Microtubes of 2 mm diameter were used as drippers or emitters. The heart of the system was the distributor which was developed in K.A.U. Microtube taken from the lateral was connected to the distributor and four microtubes connected to the distributor acted as emitters. The distributor could deliver irrigation water at a slow rate of 1 to 5 litres per hour from each microtube.

Biometric observations on the plants were taken during the experiment. For ashgourd 30% less water was needed in drip method to get the same yield as in basin method. In cucumber the amount of water needed to get same yield in both crops was same. But conveyance loss was practically nil in the case of drip method. In this experimental field there was a conveyance loss of 27.7% in one hectare of land. This water could be saved using drip method and it could be utilised for bringing more area under irrigation.

Special skill was not required for the fabrication, installation, maintenance and operation of KAU drip irrigation system. The cost of installation and operation of KAU drip irrigation system in one hectare was worked out for the crop ashgourd and it was compared with the basin method of irrigation. Comparison showed that there was a saving of Rs. 1105/- in drip method of irrigation.