PERFORMANCE EVALUATION OF WICK IRRIGATION IN COMPARISON WITH DRIP AND CONVENTIONAL METHODS OF IRRIGATION FOR AMARANTHUS ON ROOF TERRACE

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PROJECT REPORT

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Faculty of Agricultural Engineering & Technology

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Department of Land & Water Resources & Conservation Engineering

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Tavanur - 679 573

Malappuram

1994

DECLARATION

We hereby declare that this project report entitled **"Performance Evaluation of Wick Irrigation in Comparison with Drip and Conventional Methods of Irrigation for Amaranthus on Roof Terrace"** is a bonafide record of project work done by us during the course of project and that the report has not previously formed the basis for the award to us of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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Tavanur,

9th December, 1994.

CERTIFICATE

Certified that this project report, entitled **"Performance Evaluation of Wick Irrigation in Comparison with Drip and Conventional Methods of Irrigation for Amaranthus on Roof Terrace"** is a record of project work done jointly by **Bijukumar, K., Menon Rekha Ravindra, Rejani, R. and Yamuna, P.S.** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to them.

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Above still, we bow our head before God Almighty in enabling us to complete this work and for his blessings.

BIJUKUMAR, K.

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SYMBOLS AND ABBREVIATIONS USED

Agril.	-	Agricultural
cm	-	centimetre(s)
Dept.	-	Department
Engng.	-	Engineering
_et al_.	-	and others
etc.	-	et. cetera
Fig.	-	Figure
hrs.	-	hours
HDPE	-	High Density Poly Ethylene
IW/CPE	-	Irrigation water per cumulative pan evaporation
J	-	Journal
KAU	-	Kerala Agricultural University
KCAET	-	Kelappaji College of Agricultural Engineering and Technology
kg	-	kilogram
kg/mm	-	kilogram per millimetre
l	-	litres
lph	-	litres per hour
LWRCE	-	Land and Water Resources and Conservation Engineering
m	-	metre(s)
M ha	-	million hectare
mm	-	millimetre(s)

No.	-	number
pp	-	pages
Proc.	-	Proceedings
PVC	-	Poly Vinyl Chloride
°C	-	degree celcius
/	-	per
%	-	per cent
i.e.	-	that is

INTRODUCTION

Man has always been conscious of the fact that food is one of the basic daily needs and that he has to struggle to obtain it. He has therefore, always been anxious about its steady supply. It was however, the pronouncement of Malthus in the year 1798 that the population would always increase to the limit of food supplies that drew the attention of the world to the likely catastrophe of starvation as a result of unlimited increase in population. Today it is clear that the world population is indeed rapidly increasing and will continue to do so even if the growth rate declines from the rate of last 20 years. Also the increase is greatest in the developing countries. Europe in the last century saw major changes with the diversion of labour from agriculture to industry and a corresponding movement from country to town accompanied by a rapid increase in population. This pattern is now appearing in many developing countries. Although the food producing capacity has increased tremendously in the course of time, the problem of providing food to everyone atleast at a minimum level required for normal growth and activity continues to haul the world.

The possibilities of increasing food production are:

(a) Increasing the yield

(b) Developing new food sources

(c) Increasing the area of cultivated land

India's geographical area is 328.73 million hectare out of which the net sown area in 1989-'90 amounts to 139.52 Mha which is 1.4 Mha less than the area sown in 1986-'87. Also that the steady increase in the population of the country is making it necessary for a major portion of the arable land to be converted to non-agricultural uses like housing. This area has been increasing steadily from 9.36 Mha in 1950-'51 to 21.24 Mha in 1989-'90. This conversion of agricultural land to concrete jungles cannot be checked completely. This necessitates the need for an alternative to increase the cropped area. Moreover in modern times, houses with a compound especially in cities and towns are becoming rare and skyscrappers are replacing such houses. As a result the private house gardens are vanishing and the only places left for gardening are the roofs of houses and the balcony. It is in this context that a new thrust is being given to roof terrace cultivation. Cultivation of horticultural crops have been successfully carried out in the roof terrace in pots and soil beds within masonry frame work and sacks or bags.

The limitations encountered in a roof garden are totally different from gardens at ground. Since garden is at a high level from ground, the cost of maintenance may go up as everything has to be carried up. But the more fundamental difference is the depth of soil at the ground level. At ground level depth is unlimited with a source of ground water, whereas in roof, depth of soil is shallow, not exceeding 90 cm, generally varying between 20 to 60 cm. Since drainage is good water has to be replenished by frequent watering.

Certain points to be checked before starting roof gardening are:

(i) Continuous beds of soils between parapet and a shutter of bricks, wood etc. But it is better to place it in a series of boxes which facilitates better drainage and passage of air.

(ii) Roof surface should bear weight of soil. Wet soil weighs more.

(iii) Roof should be made waterproof to prevent seepage of water into rooms below.

(iv) Adequate drainage should be there.

Among the inputs to agriculture, water plays a major role, but the erratic distribution of rainfall, its uncertainty in occurrence marked by prolonged dry spells and aberration in time of commencement and withdrawal stand in the way for depending on nature for this input. This forces agriculturists to look for means for supplementing the water available from rainfall by irrigation. Irrigation plays and shall continues to play a very important role in the development of agriculture in India. In India, irrigation is mostly done by traditional surface methods of irrigation like, border, check basin and furrow irrigation methods. However these methods are not practicable on a roof terrace. Also it results in wasteful use of precious water. The most important aspect of modern irrigation is water management. It is in this context that new irrigation techniques like sprinkler drip and wick irrigation become relevant.

Though sprinkler and drip irrigation methods are versatile means of applying water with numerous advantages, their use on small scale agriculture like roof terrace cultivation is not justified due to the high capital investment involved. From the point of view of economy and efficient water application wick irrigation which is a comparatively new entrant to the irrigation scenario has gained much importance especially in cases of pot culture and roof terrace cultivation.

Wick irrigation is basically a cropping system in which water and dissolved plant food are conveyed constantly and continuously to the plants by means of sucking wicks. The system works by the capillary movement of water through the micropores within the wick dipped in the irrigation water kept in a suitable container induced by the attraction of water into hair like openings or capillary pores. This depends upon cohesion of water and adhesion of water to the material of wick.

This results in the wick being wetted. A water potential gradient comes into existence between the dry soil and the wet wick causing the water to ooze out into the soil. This water inturn spreads out into the root zone.

To evaluate the performance of wick irrigation in comparison with drip and conventional irrigation methods on a roof terrace the present study was conducted with the following specific objectives.

(i) To study the growth and canopy spread in amaranthus under wick, drip and conventional irrigation systems.

(ii) To compare the yields of amaranthus under above said treatments.

(iii) To compare the wateruse efficiency of above said treatments.

REVIEW OF LITERATURE

Wick irrigation is a relatively new irrigation technique in which water is supplied to the plant root zone constantly and continuously from a water source through the capillaries of a wick dipped in the irrigation water. This system owes its origin to the idea of capillary irrigation using glasswool by Sryotvatka in 1984. Capillarity depends both on cohesion of the liquid and on the adhesion of the liquid to solid walls. The height to which the liquid rises is determined by the surface tension and the weight of the liquid column.

Figure 1 is the schematic illustration of the rise of water in a tube of capillary dimensions. A pressure difference exists across a curved air water interface, with the pressure under the concave meniscus smaller than the pressure under the plane meniscus of the same liquid at the same height. This causes the water to rise in the capillary. The side of the capillary tube attract the water so that a concave meniscus is formed as a result of surface tension. Such capillary attraction or capillary lift occurs only in a medium in which the walls of the capillary have more

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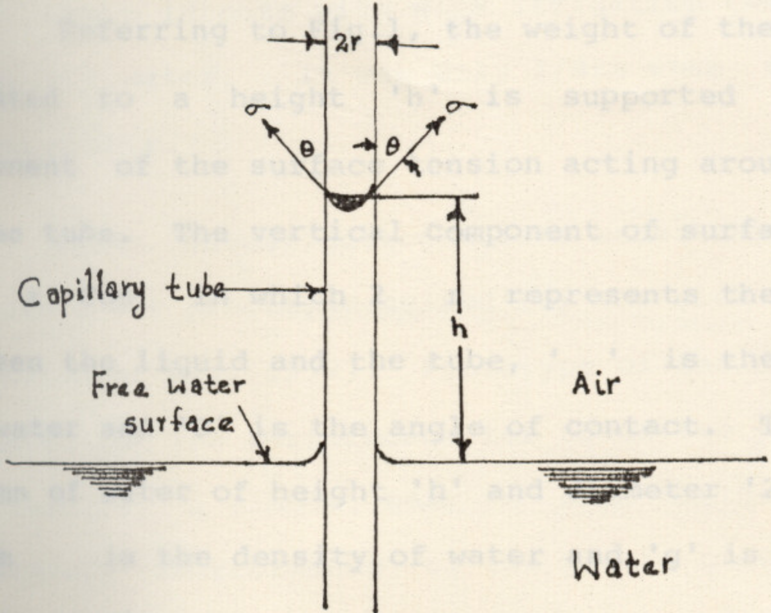

FIG.1 RISE OF WATER IN A CAPILLARY TUBE

attraction for the liquid than the molecules of the liquid have for each other.

Referring to Fig.1, the weight of the column of water elevated to a height 'h' is supported by the vertical component of the surface tension acting around the perimeter of the tube. The vertical component of surface tension force is 2 r Cos in which 2 r represents the line of contact between the liquid and the tube, ' ' is the surface tension of water and 'O' is the angle of contact. The weight of the column of water of height 'h' and diameter '2r' is $g\ r^2 h$, in which is the density of water and 'g' is the acceleration due to gravity.

Equating the two,

$$2\ \ r\ \ \mathrm{Cos}O = g\ \ r^2\ h$$

$$h = \frac{2\ \ \mathrm{Cos}O}{g\ \ r}$$

In order to make the original system economically more feasible by incorporating locally available material, the use of coir ropes as wicks was examined. Study of the growth and yield of cowpea and amaranthus under wick irrigation was studied by Rajendran and Mohammed (1991) in comparison with manual watering. Ordinary plastic buckets were used as pots and 2 coir wicks were provided per plot. Results indicated that there was no significant difference between the growth and yield of plants under the different treatments. Also plants grown in pots with wick irrigation consumed much less amount of water. It was only 1/8th when compared to the control plants.

Later investigations were undertaken to design and evaluate a pot prototype suited for the wick irrigation system (Rajendran et al., 1992). Prototype of the new garden pot was evaluated for its performance for about two years and based on the results, a simple, easy to make earthern-ware pot was fabricated. Performance of the plants grown under the two system (Wick system and traditional system) in terms of their vegetative growth showed that better growth and increased vigour are exhibited by the plants grown in the wick system.

To study the performance, root growth and root distribution in vegetable growth pattern, vegetable crops at varying planting densities were grown in the earthernware pots with wick system developed by KCAET, Tavanur (Rajendran and Sathyajith, 1993). Results showed that the increase in yield due to wick system was more pronounced at a higher plant population per plot and longer roots are produced under conventional system in all crops irrespective of per pot plant population. However, the increased root length did not cause a proportional increase in yield in any of the crops

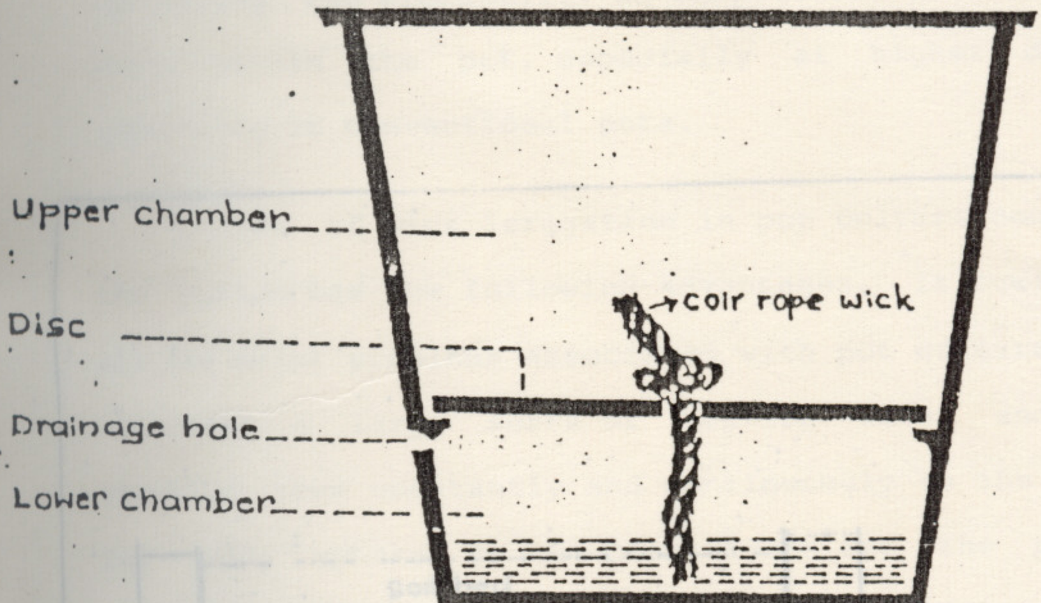

Fig. 2. Wick irrigation system

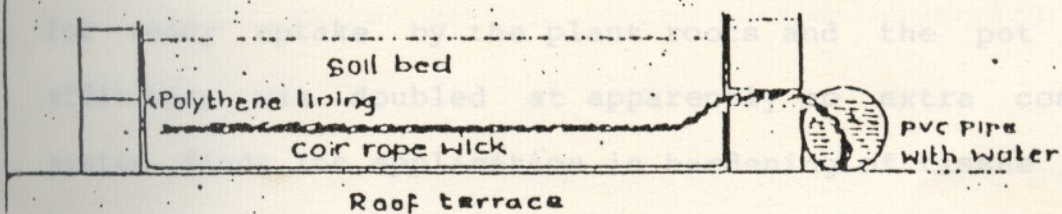

Fig. 3. Wick Irrigation system for roof terrace

indicating the probability of competition between the plant roots within the pot, especially at higher densities of population in conventional pots.

Use of wick irrigation in pot culture concluded that the system has the following advantages. It could eliminate all the major problems associated with pot culture. The system conserved a large share of applied water and nutrients, recycled them constantly and continuously to the right place for ready uptake by the plant roots and the pot cropping efficiency was doubled at apparently no extra cost. The system finds its application in hardening of tissue cultured plants augmenting and cropping (desert farming) and indoor gardening at low cost.

A trial was conducted with a view to develop the wick system for cropping on flat root tops (Rajendran and Sathyajith, 1993). Bhindi was grown on soil bed formed on roof terrace and was irrigated with wick system. A PVC tube plugged at both ends was filled with water and nutrients and coir ropes which drew water and plant food from the tube was laid across the bed to convey them into the soil. The performance of the crop was compared with another bhindi crop grown on a similar bed but irrigated conventionally. Results showed that the yield could be doubled in bhindi by high density planting with wick system. This indicates that the wick system would be a viable means for maximising production from the available space.

A study on comparative evaluation of drip and conventional method of irrigation and to evaluate the water requirement of cool season vegetables was conducted by Sheela (1993). It was found that drip irrigation was significantly superior to basin irrigation. With half the quantity of water applied in Basin method, drip method gave significantly superior yield than basin method.

A similar study conducted by Sheeja (1989) on ashgourd and cucumber also obtained identical results. The study concluded that there were significant differences between the treatments with regard to the yield. Also considerable saving in the amount of water used was achieved using drip irrigation.

MATERIALS AND METHODS

A study on the behaviour and performance of wick irrigation in comparison with drip and conventional irrigation methods on a roof terrace was conducted at K.C.A.E.T, Tavanur. The materials used and methodology employed for experimentation, data collection and analysis are presented in this chapter.

3.1 Location

The location of the experiment was on the roof terrace of the department of L.W.R.C.E. at K.C.A.E.T., Tavanur in Malappuram district of Kerala. The place is situated at 10° 53' 30" North latitude and 76° east longitude.

3.2 Climate

Agroclimatically the area falls between the borderline of northern zone, central zone and kole zone. climatologically the area is under low rainfall zone with a rainfall of 1000-2000 mm. The area receives rainfall mainly from south west monsoon and to a certain extent from north east monsoon.

3.3 Site preparation

Site selection was performed after giving due consideration to get maximum intensity of sunlight without obstructions and to the availability of water near the site.

3.4 Bed preparation

Bricks were laid to a height of 20 cms, width of 60 cm and length of 100 cms to prepare a suitable framework for the bed. The interior walls of this framework were then lined with polythene sheets to prevent seepage of water. The soil bed was made of potting mixture of well-graded soil, sand and farm yard manure in the ratio 1:1:1 and was filled to a depth of 1 cm below the brim of the framework. Holes were provided at the lower side of the sheets for proper drainage.

3.6 Crop raising

Out of the various varieties of amaranthus developed by the KAU, the Kannara Local variety was selected for growing in the plots.

The seeds were first sown in the nursery on 1st September, 1994. They were then transplanted to the prepared beds on the terrace. As the usual practice, transplanting was done during evening hours. Irrigation was done soon after transplanting. The nutrients required was supplied by the

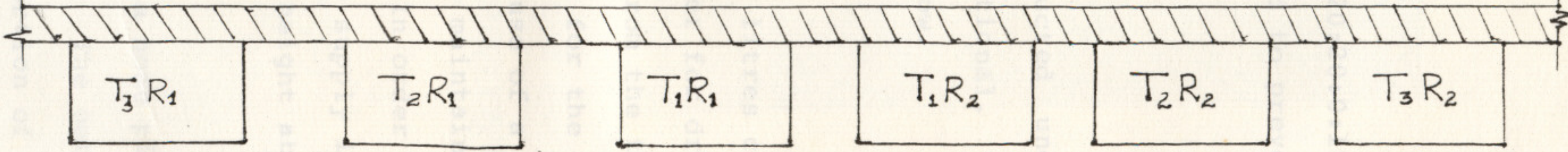

FIG.4 SCHEMATIC DIAGRAM OF THE EXPERIMENTAL LAYOUT

application of Factomphos 20:20:0:15 in 3 doses. The pesticide 'Furadan' was applied to prevent the attack of pests and diseases.

Irrigation systems

The study was conducted under three irrigation systems, Drip, Wick and Conventional. The components used in the study are as described below.

3.7 Storage tank

An oil barrel of 200 litres capacity was used as a storage tank for providing water for drip irrigation. It was installed at a height of 5 m from the terrace level. This was to provide the necessary head for the operation of the drip irrigation system without the use of a pump. The water level in the storage tank was always maintained between 60 to 80 cm from the bottom of the tank. In order to prevent the entry of suspended inpurities into the supply line, the outlet of the tank was provided about 10 cm height above the bottom of the tank.

Drum was filled with a hose pipe which was connected to a pipeline near the plot. The outflow was regulated by means of a tap. The inner portion of the outlet was covered with plastic wire mesh to prevent impurities from entering

Plate 1. View of the storage tank for drip irrigation

Plate 2. View of the set up for drip irrigation

into the pipe. The outflow from the tank was taken only after all agitation had subsided and proper sedimentation of all impurities was achieved. This was to prevent the clogging of the emitters, since no filter was supplied in the supply line.

3.8 Main line

Black HDPE pipe of size 16 mm diameter was used as the main supply line. The length of the main was 20 m. The end of the main line was plugged using end plugs which can be removed to facilitate flushing.

3.9 Microtubes

Black HDPE pipes of 6 mm diameter was used as microtubes and were laid in between two consecutive rows of plants. Microtubes of two different lengths namely 1 m and 80 cm were used.

3.10 Emitter

Pressure compensating, self flushing drippers with a discharge of 8 lph were used as emitters. The emitters were push fitted into the holes made by the dripper punch on the lateral. The discharge point of each emitter was inserted into the root zone of the plant in the plot. The four plants were provided with one emitter. The components of the drip system are shown in the Fig.1 and 2.

3.11 Basin

Plastic basins of 4 litres capacity were used as containers of water in the wick irrigation method. Each basin was of 20 cm diameter and depth 13 cm. Each wick was supplied with water from a basin. A total number of four basins catered to one plot. To prevent surface evaporation of water, the mouth of basins were properly secured with polythene sheets.

3.12 Coir wicks

One centimetre diameter coir wicks of length 0.5 m were laid at a depth of 10 cm below the soil surface. One end of the wick was kept immersed in the water in the basin. Wicks were laid in between the crop rows. The portion of the wick between the basin and soil were covered with PVC tube of 1.2 cm diameter. This was to check the evaporation of water.

3.13 Methodology employed

The experiment plots for the different treatments were laid out separately. Each treatment was replicated twice and labelled R_1, R_2 etc. The rates of water for the different treatments were decided depending on IW/CPE ratio i.e., the ratio of irrigation water applied to the cumulative pan

Plate 4. View of the containers for wick irrigation with cover partially folded

Plate 3. View of the containers for wick irrigation without cover

evaporation. The treatments were labelled as T_1, T_2 and T_3. The following table gives the description of these treatments.

Table 1. Details of the treatments

Treatments	Irrigation method	IW/CPE
T_1	Drip	0.75
T_2	Wick	--
T_3	Conventional	1.00

The value for IW/CPE ratio for the treatments T_1 and T_3 were fixed at 0.75 and 1.00 respectively on the basis of the results of a former study.

The area of each plot amounted to 0.6 m^2 in which 15 plants were planted at a row to row and plant to plant spacing of 20 cms as per the recommendation in the package of practices. Initially, two plants were planted at each point. After 2-3 days, the unhealthy plants were removed and the density was thinned to one plant per point.

3.14 Schedule of irrigation

During initial days common irrigation was given to all the plots with water sufficient to ensure the survival of the plants. After the thinning down of the number of plants in each plot, irrigation schedule based on IW/CPE ratios was employed in the treatments T_1 and T_3.

Drip and conventional irrigation was given every day depending on the evaporation value of the previous day. For example, if the evaporation of the previous day was 4 mm, in treatment T_1 (IW/CPE = 0.75), the depth of irrigation was given was 3 mm. For treatment T_3 (IW/CPE = 1) the depth of irrigation given was 4 mm.

The details of irrigation are given in Table 1. Rain occurred towards the end of 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 4 mm and rainfall was more than 4 mm on a particular day, no irrigation was done on the next day in the drip and conventional plots. If the rainfall was less than 4 mm that was subtracted from the amount of evaporation and the quantity of water applied as irrigation was based on this balance.

The methodology employed in the application of irrigation water in treatment T_2 is as follows. The fall in the depth of water contained in the basis were noted daily and after a fall in depth of about 5 to 6 cms, water was added so as to bring the water level back to the brim of the container.

The amount of water thus added was also noted down. The details of the irrigation water taken up by the treatments is given in Appendix-I.

RESULTS AND DISCUSSION

The different results obtained from the study are discussed below.

The biometric observations taken on the crops were plant growth parameters and the yield. Plant growth was assessed at three to five days intervals. Measurement of height and canopy spread were taken in for the plants from each plot. Yield from the plants was assessed on the basis of fresh weight of the shoot of the plants. Dry weight of the plants was also obtained.

4.1 Height of the plants

Height was evaluated as the distance from the cotyledonary node to the base of the petiole at the tallest growing point. The results of this observation is given in Tables 2 to 7 and is represented diagramatically in Fig.5.

Statistical analysis of the data disclosed that there is no significant difference between the treatments ($P<0.05$).

Growth curves of the treatments showed a sigmoidal curve.

Table 2. Height of plants in cm as observed on 14.09.'94

	T_1		T_2		T_3	
	R_1	R_2	R_1	R_2	R_1	R_2
1.	4.2	6.1	4.2	4.6	5.1	4.0
2.	4.5	4.6	7.4	7.4	4.1	4.8
3.	4.9	6.7	7.3	3.9	6.0	3.9
4.	4.7	4.0	3.8	7.1	3.9	7.5
5.	5.4	5.5	6.1	7.1	5.4	6.9
6.	4.1	5.7	5.8	4.4	6.2	5.3
7.	4.9	5.6	3.9	3.6	3.7	3.6
8.	5.3	5.7	4.8	7.6	5.2	5.9
9.	5.4	4.9	3.7	4.6	6.1	6.2
10.	5.6	4.4	4.1	6.8	3.4	3.7
11.	6.4	4.8	7.2	7.2	3.9	6.0
12.	4.3	5.5	4.2	4.0	6.6	6.9
13.	6.2	4.9	4.7	4.9	4.7	3.8
14.	4.7	6.0	7.3	6.6	7.3	3.5
15.	6.1	6.2	6.6	7.3	5.8	5.1

Table 3. Height of plants in cm as observed on 19.09.'94

	T_1		T_2		T_3	
	R_1	R_2	R_1	R_2	R_1	R_2
1.	7.8	9.1	8.5	7.9	10.3	7.1
2.	8.2	6.5	11.8	11.6	7.2	7.7
3.	8.9	6.2	7.5	11.4	12.3	6.9
4.	8.5	6.5	11.5	7.2	6.8	12.1
5.	9.1	8.6	11.4	9.2	11.1	11.2
6.	7.5	8.8	7.8	9.1	12.7	8.0
7.	8.7	8.4	7.5	7.8	6.1	5.6
8.	10.2	9.4	12.2	9.7	10.8	9.8
9.	9.6	7.9	8.5	7.7	12.5	10.6
10.	9.1	7.3	10.5	8.2	5.3	6.3
11.	9.3	6.9	10.9	12.6	6.7	10.4
12.	7.0	8.8	7.7	7.3	13.1	11.7
13.	11.1	7.6	8.8	8.6	7.7	6.0
14.	8.3	8.9	10.3	12.2	13.6	5.2
15.	10.9	9.3	11.5	10.2	11.9	8.2

Table 4. Height of plants in cm as observed on 24.09.'94

	T_1		T_2		T_3	
	R_1	R_2	R_1	R_2	R_1	R_2
1.	17.6	17.0	15.0	14.6	15.6	13.3
2.	16.4	15.5	16.1	16.6	13.4	14.0
3.	16.8	13.3	16.0	12.8	17.9	12.5
4.	15.9	15.0	12.3	16.1	12.9	21.5
5.	16.6	16.9	14.0	15.8	17.0	17.6
6.	18.2	17.2	14.1	13.0	18.5	15.4
7.	17.1	16.9	12.4	12.4	12.4	10.5
8.	15.7	17.4	14.1	17.2	16.2	15.0
9.	17.2	16.4	13.0	14.0	18.2	15.6
10.	16.3	15.1	13.5	15.2	10.7	12.6
11.	17.7	13.8	18.3	16.4	12.5	15.4
12.	17.2	17.1	12.5	13.2	18.8	16.4
13.	18.5	16.2	14.0	14.5	14.2	12.1
14.	16.5	16.8	17.5	14.7	19.1	10.5
15.	18.3	17.3	15.0	16.4	17.9	17.5

Table 5. Height of plants in cm as observed on 27.09.'94

	T_1		T_2		T_3	
	R_1	R_2	R_1	R_2	R_1	R_2
1.	25.5	25.5	21.5	22.7	26.1	24.1
2.	24.3	23.4	25.5	24.4	25.1	25.7
3.	25.0	21.9	24.5	21.2	28.2	24.0
4.	24.7	22.6	20.1	23.9	25.2	34.5
5.	24.2	24.4	21.3	23.5	27.4	29.5
6.	25.7	25.1	22.0	21.2	28.7	27.2
7.	24.9	24.3	20.5	20.2	24.3	22.1
8.	24.5	24.9	22.5	24.8	26.8	26.6
9.	25.3	23.6	20.8	22.6	28.3	26.9
10.	23.7	22.9	21.1	24.2	22.0	24.6
11.	25.1	20.8	26.1	26.2	24.7	27.6
12.	24.9	24.7	21.1	22.0	29.2	27.2
13.	26.2	23.2	22.0	22.7	25.3	23.3
14.	23.9	24.9	25.0	22.9	29.4	21.5
15.	25.9	25.7	24.7	23.8	28.2	28.7

Table 6. Height of plants in cm as observed on 30.09.'94

	T_1		T_2		T_3	
	R_1	R_2	R_1	R_2	R_1	R_2
1.	31.8	31.6	30.5	31.9	35.6	39.6
2.	31.1	31.0	35.5	37.1	36.2	38.9
3.	31.0	29.6	37.0	31.6	38.0	41.4
4.	30.4	30.3	30.3	36.7	48.0	39.4
5.	30.6	32.8	31.4	36.1	42.6	40.8
6.	32.1	33.2	31.5	31.3	40.6	41.9
7.	31.4	32.1	30.1	31.0	34.6	38.1
8.	30.6	32.5	32.8	37.3	39.2	40.1
9.	31.7	31.8	31.0	32.3	39.8	41.6
10.	29.5	30.7	31.2	36.3	38.4	35.4
11.	30.9	28.3	36.0	36.7	40.8	38.6
12.	30.8	30.6	32.0	32.6	40.8	42.2
13.	32.5	30.9	32.5	32.3	36.7	39.1
14.	30.2	31.2	35.5	34.8	34.0	42.5
15.	32.2	32.1	36.8	35.2	43.1	41.4

Table 7. Height of plants in cm as observed on 03.10.'94

	T_1		T_2		T_3	
	R_1	R_2	R_1	R_2	R_1	R_2
1.	43.9	43.0	39.0	42.0	46.0	43.8
2.	41.0	41.0	46.0	48.6	45.2	45.6
3.	41.7	38.7	49.0	42.3	49.3	43.2
4.	39.6	39.5	41.0	48.2	45.0	56.0
5.	41.0	42.3	45.5	47.7	47.1	53.0
6.	42.8	42.8	40.5	39.2	52.7	48.2
7.	42.8	42.2	40.2	38.9	44.6	41.8
8.	38.8	42.5	43.7	48.9	46.5	45.3
9.	40.4	41.4	43.6	42.3	50.9	46.7
10.	38.9	40.0	44.0	47.6	41.5	44.6
11.	0.4	37.5	47.3	47.1	44.9	52.8
12.	39.6	39.9	41.0	42.7	53.6	46.9
13.	43.7	40.7	43.3	43.8	45.6	41.8
14.	42.2	42.6	46.7	45.4	54.3	40.2
15.	43.5	43.7	46.3	46.1	49.3	52.9

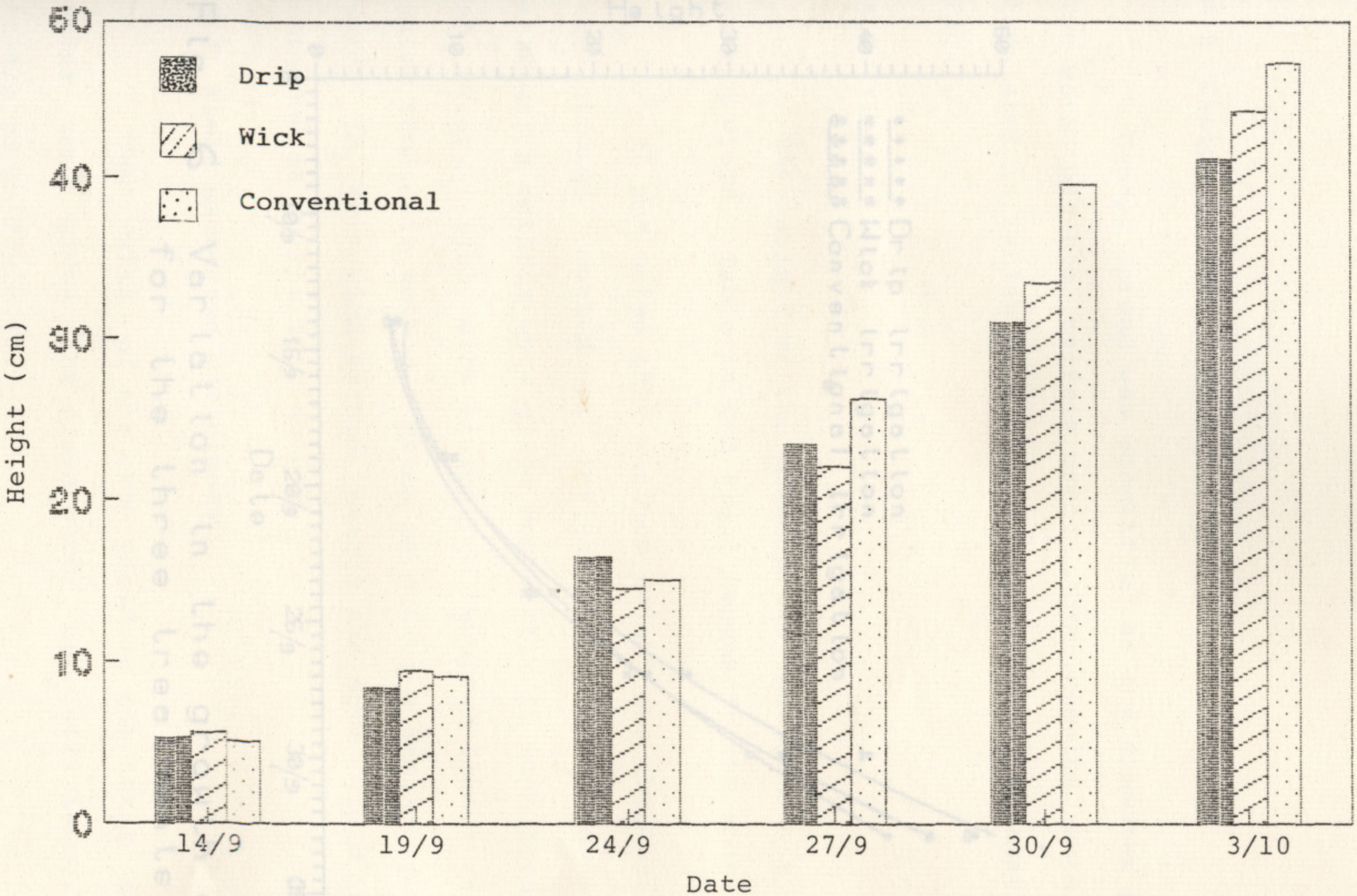

FIG.5 VARIATION IN HEIGHT OF PLANTS FOR THE THREE TREATMENTS

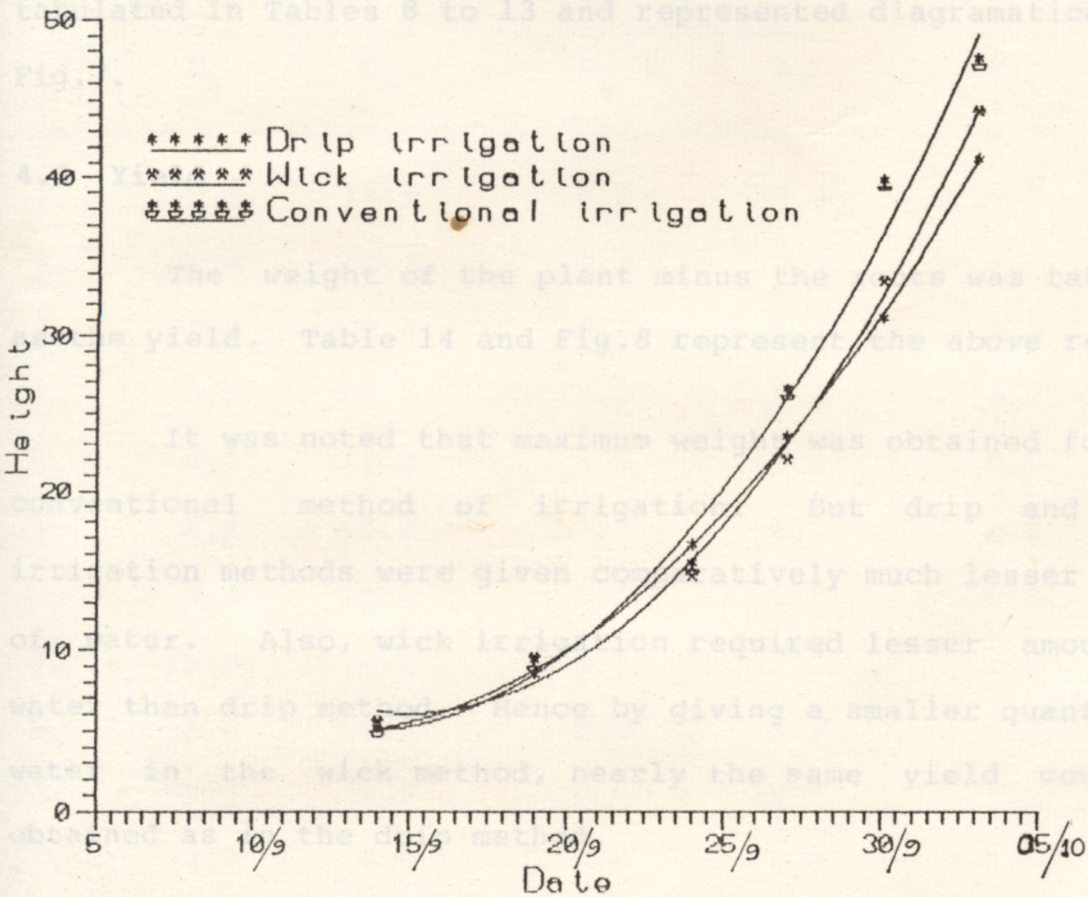

Fig. 6 Variation in the growth curve for the three treatments.

4.2 Canopy spread

Canopy spread was quantified as the diameter projected by each plant's surface area. The results obtained are tabulated in Tables 8 to 13 and represented diagramatically in Fig.7.

4.3 Yield

The weight of the plant minus the roots was taken in as the yield. Table 14 and Fig.8 represent the above result.

It was noted that maximum weight was obtained for the conventional method of irrigation. But drip and wick irrigation methods were given comparatively much lesser amount of water. Also, wick irrigation required lesser amount of water than drip method. Hence by giving a smaller quantity of water in the wick method, nearly the same yield could be obtained as in the drip method.

4.4 Field water use efficiency

The ratio of the crop yield to the total amount of water used gives the field water use efficiency. It is tabulated in Table 14.

It is clear that the water use efficiency was maximum for wick irrigation and least for conventional irrigation.

Table 8. Canopy spread of the plants in cm as observed on 14.09.'94

	T_1		T_2		T_3	
	R_1	R_2	R_1	R_2	R_1	R_2
1.	7.1	11.6	7.1	7.7	7.7	6.8
2.	8.5	9.7	9.7	7.2	6.9	7.7
3.	6.9	8.8	8.8	6.8	9.1	6.6
4.	7.2	10.1	7.0	9.5	6.7	10.4
5.	9.1	11.2	6.9	9.8	8.3	9.3
6.	8.8	11.4	7.3	8.7	10.1	8.2
7.	9.3	10.9	6.7	6.8	6.6	6.4
8.	10.2	11.1	9.9	7.2	7.9	8.8
9.	10.6	10.2	6.9	8.9	9.2	9.1
10.	7.7	9.9	9.6	10.1	7.1	6.5
11.	7.2	9.3	7.5	9.6	6.6	8.7
12.	8.3	10.4	10.0	7.4	11.6	9.8
13.	11.2	12.3	10.2	6.7	7.4	6.7
14.	7.5	11.9	7.6	9.8	11.6	6.4
15.	10.9	12.5	9.7	8.9	8.7	7.6

Table 9. Canopy spread of the plants in cm as observed on 19.09.'94

	T_1		T_2		T_3	
	R_1	R_2	R_1	R_2	R_1	R_2
1.	15.1	19.2	15.8	16.4	18.6	15.6
2.	12.2	15.6	17.8	16.0	15.8	18.4
3.	14.6	14.3	16.0	13.7	19.2	14.3
4.	16.7	14.9	14.8	17.2	14.6	21.8
5.	15.9	17.5	14.5	17.7	19.3	20.4
6.	14.8	18.3	14.8	15.8	20.3	19.1
7.	17.1	17.1	13.9	14.1	14.4	13.9
8.	16.7	18.2	17.2	15.8	18.8	19.8
9.	17.2	16.7	14.1	16.2	20.3	20.2
10.	18.1	16.4	17.4	18.3	14.7	14.0
11.	15.8	15.7	16.1	17.5	14.2	19.6
12.	16.1	17.1	17.9	15.8	21.4	21.0
13.	17.3	19.4	18.9	13.9	17.3	15.0
14.	18.7	18.6	16.0	17.5	22.2	14.2
15.	19.2	19.7	17.5	16.0	20.1	18.3

Table 10. Canopy spread of the plants in cm as observed on 24.09.'94

	T_1		T_2		T_3	
	R_1	R_2	R_1	R_2	R_1	R_2
1.	27.0	26.2	27.0	27.8	30.0	27.0
2.	28.5	24.3	30.3	27.1	27.0	27.9
3.	24.5	23.6	28.7	23.6	33.0	25.3
4.	26.7	24.5	26.9	30.0	26.9	30.5
5.	25.0	26.3	25.8	30.2	31.3	29.8
6.	23.0	26.0	26.7	28.5	32.1	27.6
7.	26.3	26.1	24.1	24.3	26.3	24.4
8.	25.9	25.6	30.0	27.2	30.8	28.3
9.	26.8	24.8	25.4	29.3	30.8	31.2
10.	24.0	24.6	30.2	30.9	32.2	23.7
11.	25.0	23.2	27.5	29.8	25.4	28.5
12.	26.1	25.9	30.6	28.0	30.9	32.3
13.	27.5	26.0	31.7	25.5	29.6	26.1
14.	25.6	24.0	28.2	30.5	38.8	25.8
15.	27.0	27.5	30.3	28.9	29.7	27.5

Table 11. Canopy spread of the plants in cm as observed on 27.09.'94

	T_1		T_2		T_3	
	R_1	R_2	R_1	R_2	R_1	R_2
1.	32.5	30.7	33.3	32.8	35.0	34.6
2.	31.3	30.1	36.1	33.6	35.3	35.4
3.	32.5	28.9	32.4	27.9	37.1	36.1
4.	32.6	30.2	30.0	34.2	35.0	38.3
5.	30.7	30.0	30.2	33.9	36.2	37.6
6.	29.0	30.5	29.8	32.0	37.3	36.3
7.	31.9	32.0	28.7	29.0	32.9	33.3
8.	30.8	30.2	34.0	33.5	36.2	39.9
9.	30.6	30.1	30.5	32.8	35.8	39.8
10.	31.2	29.8	34.0	37.1	37.4	34.7
11.	30.0	29.0	32.8	34.3	33.9	41.5
12.	30.4	30.0	35.0	30.3	40.0	37.0
13.	33.1	29.6	33.3	34.6	35.0	36.8
14.	34.5	32.0	34.1	32.5	34.3	40.7

Table 12. Canopy spread of the plants in cm as observed on 30.09.'94

	T_1		T_2		T_3	
	R_1	R_2	R_1	R_2	R_1	R_2
1.	34.0	34.8	37.1	37.0	43.0	48.2
2.	33.2	35.3	38.7	37.4	46.5	47.1
3.	34.0	35.8	35.2	33.0	44.8	48.3
4.	34.1	34.6	34.8	36.9	42.7	49.7
5.	33.4	34.4	33.5	37.4	43.8	46.0
6.	35.0	35.1	31.3	35.1	44.1	48.3
7.	34.7	36.0	33.6	37.2	43.7	47.4
8.	35.1	34.9	37.9	36.9	45.5	49.8
9.	33.9	34.0	34.9	36.0	44.7	50.0
10.	36.0	34.7	37.1	42.3	45.3	47.5
11.	33.6	35.3	36.9	37.3	43.8	50.5
12.	35.7	34.0	41.3	36.8	42.9	51.6
13.	36.1	35.0	39.0	35.2	50.0	46.7
14.	36.9	37.2	37.8	37.5	45.0	47.9
15.	37.1	39.0	37.3	35.7	44.6	50.1

Table 13. Canopy spread of the plants in cm as observed on 03.10.'94

	T_1		T_2		T_3	
	R_1	R_2	R_1	R_2	R_1	R_2
1.	42.5	41.5	42.3	43.0	58.1	59.7
2.	39.5	41.7	43.9	41.9	60.0	56.4
3.	38.0	43.0	42.0	38.9	57.5	57.3
4.	38.3	41.0	40.3	43.8	56.5	58.6
5.	37.9	39.9	39.0	44.2	58.2	55.2
6.	40.0	40.8	37.5	41.6	58.8	57.1
7.	39.5	41.0	39.7	40.4	56.2	56.4
8.	39.3	39.8	44.5	42.5	55.9	59.9
9.	38.9	40.7	41.3	43.2	58.6	60.3
10.	40.2	40.1	43.4	45.0	58.7	56.5
11.	38.0	42.0	45.0	44.1	57.1	58.8
12.	38.7	41.0	46.2	44.7	56.3	60.1
13.	0.1	39.1	44.5	42.0	58.0	54.8
14.	42.3	40.8	44.0	44.9	57.4	55.5
15.	41.6	42.5	45.0	42.3	58.1	57.3

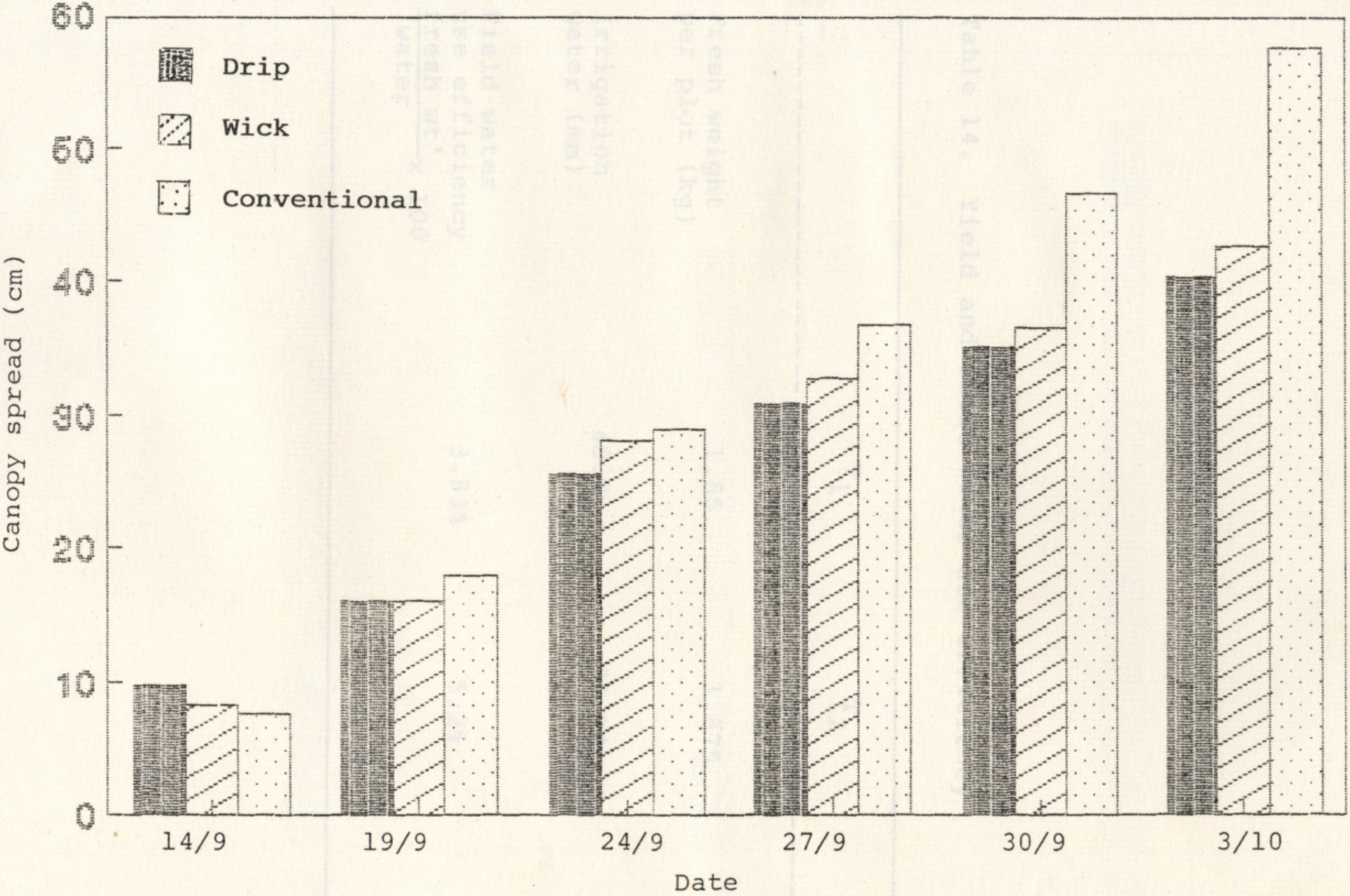

FIG.7 VARIATION IN CANOPY SPREAD OF PLANTS FOR THE THREE TREATMENTS

Table 14. Yield and field water use efficiency

	T_1	T_2	T_3
Fresh weight per plot (kg)	1.85	1.875	2.275
Irrigation water (mm)	48.3	35.94	64.4
Field water use efficiency $\frac{\text{fresh wt'}}{\text{water}} \times 100$	3.83%	5.2%	3.53%

Plate 5. Comparison of the roots.

Plate 5. Comparison of the plants.

4.5 Weight of dry matter

Dry matter of the plant shoots was obtained by oven drying at 70°C for 48 hours. It was then weighed to obtain the weight of the dry matter. The weight of dry matter showed a trend corresponding to the fresh weight.

4.6 Percentage moisture content

The moisture content of the plant shoot was estimated on a wet basis. The results obtained were almost identical as indicated in Table 15.

It indicates that the amounts of water conserved in the plants under all the three treatments were almost the same. The excess amount of water supplied could only be lost through transpiration or percolation. Thus, it could be inferred that the amount of water supplied in wick irrigation though lesser was adequate.

4.7 Other observations made during the experiment

4.7.1 Roots

It was observed that in the plants under wick irrigation the number and length of lateral roots were less than that of the other two treatments, whereas the number of root hairs were considerably more. Due to this fact we may be

Table 15. Per cent moisture content

	T_1	T_2	T_3
Fresh weight per plot (kg)	1.85	1.875	2.275
Dry matter weight (kg)	0.107	0.0999	0.152
% moisture content (wet basis)	94.2%	94.7%	93.3%

able to accommodate more number of plants per plot by reducing the spacing. This, however, require further investigation.

4.7.2 Amount of water

Wick irrigation required about 40 per cent less water than conventional irrigation. Hence there was considerable saving of water and more area can be brought under irrigation with the same amount of water. This increase in area would be greater for wick than drip irrigation method, thus producing significantly superior yields.

4.7.3 Nutritive value

Plants under the wick irrigation method were observed to have a profound greenish tinge while that under drip and conventional system yielded bright red plants. The effect of coir wicks in propagating additional chlorophyll and a resultant change in the nutritive value of the plants need to be studied.

4.7.4 Weed growth

Weed growth was found to be most in the conventionally irrigated plots and least in the drip irrigated plots.

4.7.5 Installation

The installation of the wick system was very simple and the materials used are locally available. The system was cheaper than the drip system.

4.7.6 Attention of the farmer

Water in the container for the wick method needed replenishment at 4 to 5 days intervals. For containers of greater capacity, this period could go up even further. Thus, the system demands less frequent attention than the other methods which is a boon to the busy world of today.

In the course of this study it was found that the yields were more for conventional method which consumed the comparatively greater amount of water. It may however be noted that in the case of amaranthus, the plant yield is corresponding to the vegetative growth of the plant and not to the fruit yield. Since more water was applied in conventional method (IW/CPE = 1), a more profound vegetative growth was observed. But the field water use efficiency in this case was the least. Hence it is not advantageous to use this method in regions of water scarcity like urban townships. In such regions wick irrigation system which is more efficient both in terms of field water use and economic feasibility, may be adopted with no significant decline in the yield.

SUMMARY AND CONCLUSION

In modern times, houses with a compound especially in cities and towns are becoming rare and sky scrapers are replacing such homes. As a result, the private home gardens are vanishing and the only places left for gardening are the roofs of houses and the balcony. Hence it has become necessary to evolve an economically viable and efficient system of irrigation for such cultivation. This investigation was undertaken to compare the performance of wick, drip and conventional irrigation for root gardening with amaranthus as the crop.

The experiment was conducted on the terrace of Department of LWRCE, KCAET, Tavanur and the main features of the experimental procedure is as follows:

1. Tests were conducted to determine the soil moisture constants.
2. Soil beds of 100 cm length, 60 cm width and 20 cm depth were used for the study. The beds were enclosed within shutters of bricks lined internally with polythene sheets.

3. Three treatments namely drip, wick and conventional methods were used in the study. Scheduling was based on IW/CPE ratio, its value being taken as 0.75 for drip and 1.00 for conventional method. A continuous supply of water was maintained for wick irrigation.

4. Biometric observations like the height of the plant and its canopy spread was noted at two to five days interval.

5. Fresh weight of the shoot of the plant was taken in as its yield.

6. Field water use efficiency was computed as the ratio of the yield in kg to the amount of water consumed in mm.

7. Dry weight of the plant shoots was taken in and it was used to compute the per cent moisture content.

The following results were obtained from the analysis of the data collected.

1. There was no significant difference in the vegetative growth of the plants among the treatments.

2. Field water use efficiency was maximum for wick irrigation and least for conventional irrigation.

3. Yield was more in case of conventionally irrigated plants and lowest for drip irrigated plants.

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1. There was no significant difference in the vegetative growth of the plants among the treatments.

2. Field water use efficiency was maximum for wick irrigation and least for conventional irrigation.

3. Yield was more in case of conventionally irrigated plants and lowest for drip irrigated plants.

4. Considerable saving of water was achieved in the wick irrigation system.

5. The per cent moisture content of the shoots was almost the same, irrespective of the treatment it was subjected to.

6. Installation of the wick system is simple and demands no special skill.

7. The wick irrigation system is devoid of a high capital investment and at the same time incorporates all the notable advantages offered by the drip system.

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APPENDIX I

Amount of irrigation water (l)

Date	Pan evaporation (mm)	Drip (IW/CPE= 0.75)	Wick	Conventional (IW/CPE = 1)
14/9	4.0	1.8		2.4
15/9	4.0	1.8		2.4
16/9	2.3	1.035		1.38
17/9	4.0	1.8	6.975	2.4
18/9	4.0	1.8		2.4
19/9	2.5	1.125		1.5
20/9	4.0	1.8		2.4
21/9	4.0	1.8		2.4
22/9	4.0	1.8	6.025	2.4
23/9	4.0	1.8		2.4
24/9	4.0	1.8		2.4
25/9	4.0	1.8		2.4
26/9	4.0	1.8	5.550	2.4
27/9	4.0	1.8		2.4
28/9	4.0	1.8		2.4
29/9	4.0	1.8	3.015	2.4
30/9	4.0	1.8		2.4
1/10	-0.4	–		–
2/10	0.00	–		–
Total	64.4	29.16	21.565	38.88

APPENDIX II

Analysis of results on height (cm) of the plant
Friedman's test

Date	T_1	T_2	T_3	X^2 calculated	X^2 critical
14/9	5.24 (2)	5.61 (3)	5.15 (1)		
19/9	8.51 (1)	9.57 (3)	9.16 (2)		
24/9	16.60 (2)	16.64 (3)	15.18 (1)		
27/9	23.59 (2)	22.13 (1)	26.41 (3)	2.33	5.99
30/9	31.19 (1)	33.58 (2)	39.65 (3)		
3/10	41.27 (1)	44.27 (2)	47.31 (3)		
Sum of the Ranks	9	14	13		

APPENDIX III

Analysis of results on canopy spread (cm) of the plants
Friedman's test

Date	T_1	T_2	T_3	X^2 calculated	X^2 critical
14/9	9.73 (3)	8.34 (2)	7.65 (1)		
19/9	16.10 (1)	16.15 (2)	17.90 (3)		
24/9	25.59 (1)	28.17 (2)	29.01 (3)		
27/9	30.85 (1)	32.75 (2)	36.68 (3)	5.33	5.99
30/9	35.13 (1)	36.60 (2)	46.65 (3)		
3/10	40.32 (1)	42.70 (2)	57.64 (3)		
Sum of the Ranks	8	12	16		

PERFORMANCE EVALUATION OF WICK IRRIGATION IN COMPARISON WITH DRIP AND CONVENTIONAL METHODS OF IRRIGATION FOR AMARANTHUS ON ROOF TERRACE

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ABSTRACT OF THE PROJECT REPORT

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1994

ABSTRACT

This investigation was undertaken to evaluate the performance of wick irrigation in comparison with drip and conventional methods of irrigation on the roof terrace cultivation of amaranthus. The experiment was conducted at KCAET, Tavanur during September-October 1994. Soil beds of 20 cm depth, 100 cm length and 60 cm width confined within shutters of bricks, internally lined with polythene sheets were used for growing cheera (Amaranthus gangeticus), each replicated twice. In drip and conventional methods of irrigation, irrigation schedule was based on IW/CPE ratios 0.75 and 1.00 respectively. For wick irrigation, water was sucked in continuously. Biometric observations on the plants were taken during the experiment. Analysis of the data concluded that there was no significant difference between the treatments. The field water use efficiency was found to be 5.2 per cent, 3.8 per cent and 3.5 per cent for wick, drip and conventional methods respectively. The installation of the wick system was cheap and simple compared to drip system.