

Original Research Article

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## Optimization of Lateral Depth of Subsurface Drip Fertigation for Amaranthus

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### ABSTRACT

The main concept of drip irrigation is to create a continuous wetted strip directly beneath the soil where the active roots are concentrated. The fertigation allows application of right amounts of plant nutrients uniformly to the wetted root zone. A field experiment was conducted to evaluate the effect of different fertigation levels and depth of laterals under plastic mulch on the performance of Amaranthus (*Amaranthus hypochondriacu*, variety: kannara local). The yield showed significant difference with different levels of fertigation and depth of laterals. Based on the statistical analysis the study suggested that treatment of 80% fertigation and 10 cm lateral depth is better due to the fact that it gives higher crop yields (7.2 t/ha) with substantial saving in fertilizer usage. Hence, subsurface drip irrigation of 10 cm lateral depth with 80% fertigation level under plastic mulching for amaranthus is a good option.

#### Keywords

Fertigation, Lateral depths, Subsurface irrigation, Plastic mulching

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### Introduction

The micro irrigation system is one of the most efficient methods of water application directly into soil at the root zone of plants. Micro irrigation includes mainly drip and micro sprinklers are an effective tool for conserving water resources. It is an irrigation system with high frequency application of water in and around the root zone of plant system, which consists of a network of pipes along with suitable emitting devices. It permits a small uniform flow of water at a constant discharge, which does not change significantly

throughout the field. It also permits the irrigation to limit the watering closely to the consumptive use of plants. Thus it minimizes the conventional losses such as deep percolation, runoff and soil evaporation. It also permits the utilization of fertilizer, pesticides and other water-soluble chemicals along with irrigation water for better crop response. Fertigation is the application of fertilizers, soil amendments, or other water-soluble products through an irrigation system. Benefits of fertigation over traditional broadcast or drop-fertilizing methods include: increased nutrient absorption by plants,

reduction in fertilizer and chemicals needed, reduced leaching to the water table, reduction in water usage due to the plant's resulting increased root mass's ability to trap and hold water, application of nutrients at the precise time they are needed and at the rate they are utilized. The important components of a fertigation system include drip irrigation system of suitable layout and fertigation equipment. During summer season, the available water has to be used effectively and the soil moisture has to be conserved. Mulching is a relevant practice for soil moisture conservation under this context. Fertigation along with mulching helps to achieve both the objectives of efficient utilization of available water and the conservation of soil moisture.

Plastic mulch can reduce the loss of soil moisture. Effective control of weed growth is also attained under this system. Since micro irrigation greatly enhances water, fertilizer and energy use efficiency, the sustainability in agriculture could be achieved without the burden of environmental degradation. This study has undertaken to optimize the fertigation level and depth of laterals under subsurface drip irrigation for amaranthus.

## **Materials and Methods**

The experiment was conducted at the Instructional Farm, Kelappaji College of Agricultural Engineering and Technology (KCAET), Malappuram, Kerala during the period of October 2012 to January 2013. In this study, low density polyethylene pipe of 16mm diameter was used as the laterals which were provided with individual tap to control the flow rate and end caps are provided at the end of laterals and inline drippers of 4liters per hour discharge with a spacing of 40cm were used and a dosmatic fertigation unit was used for fertigation.

## **Treatment details and Installation of drip system**

Total ten treatments were laid out for the experiment, from which nine treatments are the combination consisting of three fertigation levels and three depths of laterals and one treatment as control were shown in Table 1 and the ten treatment was replicated thrice. A pump of 4hp was used for this study. Two pressure gauges with pressure range of 0-7kg (f)/cm<sup>2</sup> were located before and after the fertigation unit for indicating the pressure in the system. PVC pipes of 90mm and 75mm diameter with pressure rating of 6kg (f)/cm<sup>2</sup> was used as the main and sub main respectively.

Raised beds of size 12x0.9m<sup>2</sup> of 30 numbers were taken and in between two beds a spacing of 15cm was given. The laterals were placed at three different depths of 10, 20 and 30cm below the soil surface. Black plastic mulch (12m length and width of 1.2 m) sheet of 30 micron was used for covering the soil and holes of 10cm diameter were punched evenly at 40cm×40cm grid points on the LDPE sheets.

## **Spacing and Transplanting of Amaranth**

In this study Amaranth (*Amaranthus spp.*) variety kannara local was chosen as an experimental plant. A spacing of 40×40cm<sup>2</sup>, recommended for amaranthus in the Package of practices recommendations: Crops (KAU, 2005) was adopted. This variety requires the water requirement of about 2l/day/plant.

Seeds were sown in the prepared soil bed of 8x1m<sup>2</sup> with a seed rate of 4.2gm/m<sup>2</sup> and two week old seedlings were transplanted to the main field. In the mulched plots seedlings were then planted in the holes. The transplanting was done at a spacing of 40cm×40cm with 60 plants in each plot.

### **Fertilizer application**

For amaranth crop the recommended dose of fertilizer requirement was 50:50:50kg/ha (KAU, 2005) fertilizer was applied as per treatments in sixteen equal splits at four days interval. Nitrogen, phosphorus and potassium were the main nutrients required for the growth and these was applied *Rajphos* as a basal dose, urea, multi K and *polyfeed* (19:19:19) through dosmatic fertigation unit except control unit from five week to thirteenth week after planting. The recommended dose of fertizer for control treatment was applied to the base of the plant. Fertilizer requirement for different treatments were shown in Table 2.

### **Experimental data**

Three plants were selected randomly from the net plot area in each treatment and were tagged to record the variations. The average girth and numbers of leaves of the randomly selected plants grown under each treatment was taken in a weekly interval and the observation was first taken two weeks after planting.

The first yield (kg/ha) was taken one month after transplanting. After the first harvest, other harvests were done at an interval of 7days. The total of the seven harvests were taken.

Statistical analysis was done by analysis of variance (ANOVA). Analysis was compared between the treatments.

### **Results and Discussion**

The following results obtained from the study were analyzed to provide basic information of different fertigation level and depth under subsurface drip irrigation and its performance on growth and yield of crop.

### **Number of leaves**

The readings of number of leaves are shown in Table 3. The maximum number of leaves was observed for the treatment 100% fertigation with 10 cm lateral depth and minimum was seen in control. In case of fertigation, it was observed that maximum fertilizer utilization is at a depth of 10cm. This clearly indicates that, for different fertigation levels, more extraction of fertilizer can be seen in 10cm depth compared to 20 and 30cm depths. But there were no significant variations in number of leaves in other treatments i.e., with 20 and 30cm depths Kant and Naoi (1998) also reported the similar results.

### **Stem girth**

The readings (Table 4) were taken upto 7week after transplanting. The maximum value obtained (5.6 cm) in the case of stem girth was observed for the treatment 100% fertigation level and 10cm lateral depth. From the first observation onwards, it is clearly seen that maximum stem girth was observed in case of treatment is having 100% fertigation level and 10cm lateral depth. The minimum value (4.2 cm) is seen for the treatment 100% fertigation level and 30 cm lateral depth. The control treatment shows 4.4 cm stem girth. The statistical analysis shows that the stem girth at different days after planting did not differ significantly with respect to the different treatments (Reddy *et al.*, 2005). The analysis also shows that for the stem girth, there was no significant difference in between replications and treatments.

### **Yield of amaranthus**

In the first harvest at 30days after planting, the high yield (0.6 t/ha) was observed for treatment 100% fertigation with 10 cm lateral and the plants in the control plot were not matured enough to harvest.

**Table.1** Treatment details

Treatments	Description
T1	120% of fertigation level, lateral of 4 l/h at 10 cm depth
T2	100% of fertigation level, lateral of 4 l/h at 10 cm depth
T3	80% of fertigation level, lateral of 4 l/h at 10 cm depth
T4	120% of fertigation level, lateral of 4 l/h at 20 cm depth
T5	100% of fertigation level, lateral of 4 l/h at 20 cm depth
T6	80% of fertigation level, lateral of 4 l/h at 20 cm depth
T7	120% of fertigation level, lateral of 4 l/h at 30 cm depth
T8	100% of fertigation level, lateral of 4 l/h at 30 cm depth
T9	80% of fertigation level, lateral of 4 l/h at 30 cm depth
C	Control

**Table.2** Fertilizer requirement per bed (Recommended dose of N: P: Kis 50:50:50 kg/ha)

Treatment (%)	Fertilizer required(g)				
	Urea (46 : 0 : 0)	Polyfeed (19 : 19 : 19)	MultiK (13 : 0 : 44)	Potash (0 : 0 : 50)	Rajphos
120	9.6	22	36	8.4	-
100	8.0	18	30	7	-
80	6.4	14.5	24	5.6	-
Control	8.0	-	-	7	9

**Table.3** Number of leaves at different intervals of days as influenced by 10 treatments

	T1	T2	T3	T4	T5	T6	T7	T8	T9	C
3Nov	16	25	13	15	17	17	12	15	19	14
10Nov	36	56	34	33	45	34	33	31	42	26
17Nov	82	99	53	51	57	61	59	63	84	47
24Nov	108	159	105	82	94	100	88	72	111	96
30Nov	169	181	139	107	115	120	129	110	121	108

**Table.4** Stem girth (cm) at different days as influenced by 10 treatments

	T1	T2	T3	T4	T5	T6	T7	T8	T9	C
3 Nov	1.5	2.4	1.6	1.8	1.6	1.5	1.4	1.5	1.5	1.4
10Nov	3.7	3.9	3.4	3.2	3.3	3.1	3.1	3.2	3.9	3.3
17Nov	4.3	4.5	4.1	3.6	3.8	3.5	3.9	3.7	4.2	3.7
24Nov	5.0	5.1	4.6	4.0	4.1	4.3	4.5	3.9	4.3	4.0
30Nov	5.3	5.6	4.8	4.3	4.3	4.8	4.7	4.2	4.5	4.4

**Table.5** Yield (t/ha) of amaranthus as influenced by different treatments

	T1	T2	T3	T4	T5	T6	T7	T8	T9	C
1 <sup>st</sup> harvest	0.56	0.60	0.46	0.31	0.15	0.19	0.28	0.43	0.26	0.00
2 <sup>nd</sup> harvest	1.39	1.65	1.30	1.24	1.30	0.77	1.11	1.12	1.14	0.65
3 <sup>rd</sup> harvest	1.11	1.25	1.20	0.55	0.88	1.02	0.87	0.69	1.03	0.78
4 <sup>th</sup> harvest	1.48	1.71	1.44	1.23	1.30	1.11	1.43	1.23	1.39	1.26
5 <sup>th</sup> harvest	1.30	1.63	1.34	1.37	1.20	1.30	1.39	1.37	1.39	1.26
6 <sup>th</sup> harvest	1.57	1.67	1.46	1.11	1.44	1.16	1.14	1.27	1.16	1.12

The readings are shown in Table 4. In the case of treatment 100% fertigation with 10cm lateral depth, the number of leaves was also more as compared with the other treatments. The yield of treatment 100% fertigation with 10 cm lateral depth is obtained increased due to higher moisture extraction. (Kant and Naoi, 1998). In treatment control, conventional practices were followed and yield per beds were observed minimum when compared to other treatments, fertigation with plastic mulching.

In statistical analysis, it was found that the treatments 120% fertigation level with 10 cm lateral depth and treatment 100 % fertigation with 10 cm lateral depth were on par with treatment 80% fertigation with 10 cm lateral depth, but other treatments were significantly varies with these treatments. In treatment 80 % fertigation level with 10 cm lateral depth, it is possible to save 20% fertilizer. Hence, this study suggested that treatment is having 80% fertigation level with 10 cm lateral depth, is better because it needs less amount of fertilizer (Table 5).

In conclusion, accurate management of water, fertilizers and lateral depth with subsurface drip irrigation systems is the next step in producing high yield. Maximum yield was observed for the treatment which is of 10 cm lateral depth with 100 % fertigation level. Statistically the treatment of 10 cm lateral

depth with 100 % fertigation level is on par with the treatment of 80% fertigation and 10 cm lateral depth. The study suggested that treatment of 80% fertigation and 10 cm lateral depth is better due to the fact that it gives higher crop yields with substantial saving in fertilizer usage. Hence, subsurface drip irrigation of 10 cm lateral depth with 80 % fertigation level under plastic mulching for amaranthus is a good option as compared with conventional methods.

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