Drip Irrigation: Will it Increase Yield in Traditional Vegetable Production System?

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Abstract

Drip irrigation systems have the highest potential water application efficiency of the irrigation system used in commercial vegetable production. Drip irrigation is a tool to reduce water use, increase fertilizer efficiency, and improve profit, while simultaneously reducing the potential risk to the environment due to enrichment of surface and ground water. This research was conducted to evaluate the effect of Low Cost Drip Irrigation System (LCDS) on the yield of Amaranth (*Amaranthus* sp), Kangkong (*Ipomoea reptans*), Yard Long Bean (*Vigna unguilata*), Green Bean (*Phaseolus vulgaris*), and Katuk (*Sauropus androgenous*) growth and yield during wet season. The experiment was conducted in the farmer site in Nanggung, Bogor from January to May 2009. Treatments (with and without LCDS) were arranged in Randomized Complete Block Design with four replications (each farmer field as one replication). The result showed no significant response of vegetable yield to the drip irrigation application during wet season. The experiment should be conducted in the dry season to evaluate the effectiveness of drip irrigation on traditional vegetable production.

Keywords: *vegetables, low cost drip irrigation, wet season, Ultisol.*

Introduction

In vegetable production, fertilization and irrigation are standard management practices that farmers traditionally observe to improve their vegetable production. They need to be efficient at these practices so as to maximize profit. Water is becoming too scarce to waste in crop production and its availability is becoming serious problem, even in the humid tropics, and particularly in the dry season (AVRDC, 2004).

In the rainfed production system area especially in Indonesia, vegetables normally can be grown during the wet season (> 200 mm/month) between December and April. During the dry season (<200 mm/month) between May and October, vegetable farmers face shortage of irrigation water which leads to drought and decreased yields.

Drip irrigation systems have the highest potential water application efficiency of the irrigation system used in commercial vegetables production. Drip irrigation reduces water use, increases fertilizer efficiency, and improves profit, while simultaneously reducing the potential risk to the environment due to enrichment of surface and ground water (Hochmuth, 1992). Field studies during the hot-dry season have shown that water use for vegetable crops can be reduced considerably with drip irrigation. For vegetable crops like tomato, cucumber, chili paper, yardlong bean, cabbage, and pak-choi, studies have shown that water use in drip irrigation was 45–75% less than furrow irrigation. Yields achieved under drip irrigation were comparable with furrow irrigation. Furthermore, nutrient uptake was more efficient in drip-irrigated vegetables (AVRDC, 2004).

Low-cost drip irrigation technology has been implemented in many countries, for example in India and Africa which have many small-scale farmers. In Indonesia, vegetable farmers have small farms averagingabout 0.3 ha, with little or no access to new technology, still practicing traditional vegetable production, and with inefficient input factors, especially in fertilizer and in water usage. Low-cost drip irrigation technology is one solution that small-scale farmers can use to increase their vegetable production through more efficient water usage, higher crop yields, reduced labour-intensive hand-irrigation of crops and flexible systems capable of accommodating a variety of plot sizes (Andersson, 2005). These technologies are cheaper, do not require electric power and are easy to install. Low-cost drip irrigation has aimed at water efficiency, plant productivity and increasing income for small-scale farmers.

This research was conducted to evaluate the effect of low-cost drip irrigation system on the yield of Amaranth (*Amaranthus* sp), Kangkong (*Ipomoea reptans*), Yard Long Bean (*Vigna unguilata*), Green Bean (*Phaseolus vulgaris*), and Katuk (*Sauropus androgenous*) during the wet season.

Materials and Methods

The experiment was conducted in Hambaro village-Nanggung, Bogor, Indonesia from January to May 2008 (wet season), in which the soil type was Ultisol, which typically has low pH and high P-fixation by Aluminium. Treatments were arranged in plots with and without drip irrigation. Low-cost drip irrigation system consisted of water bucket, valve, polytube, and micro-tube emitter which were installed in the farmer plot. This experiment was arranged in Completely Randomized Block Design with four replications (each farmer field as one replication). Each of the vegetable crops was planted in lot sizes 1.5 x 5 m. The crop management practices for each vegetable can be seen in Table 1.

Measurements of plant height and diameter were conducted for Kangkong and Amaranth at 1-4 weeks after planting; Yard-long Bean and Green Bean 1-5 weeks after planting; and Katuk 1-7 weeks after transplanting. Total weight per plant and per plot was measured for Kangkong and Amaranth, total fruit weight per plant and per plot were measured for Yard-long Bean and Green Bean. Katuk yield was measured by weighing the weight of shoots per plant and per plot. Analysis of variance data was calculated using SAS 8.12 (Sas Institut, Inc). F-test was used to find out the significant difference between treatments.

Table 1. Crop Management Practices: Vegetables Cultivar, Plant spacing, Number of Seed per Hole and Fertilizer Rate

No.	Plants	Cultivar / aksesi	Spacing	∑ seed / hole	Fertilizer
1.	Kangkong	LwLiang Local	25 cm x 15 cm	10	185 kg Urea /ha 375 kg SP-36/ha 225 kg KCl/ha
2.	Yard long Bean	777	25 cm x 30 cm	2	185 kg Urea /ha 375 kg SP-36/ha 225 kg KCl/ha

3.	Green Bean	Kencana	25 cm x 30 cm	2	126 kg Urea /ha 250 kg SP-36/ha 180 kg KCl/ha
4.	Amaranth	Local	row x 20 cm (four row / bed)	Spread in rows	112 kg Urea /ha 250 kg SP-36/ha 180 kg KCl/ha
5.	Katuk	aksesi Tegalwaru Ciampea	15 cm x 10 cm	1 transplant	100 kg Urea /ha 100 kg SP-36/ha 135 kg KCl/ha

Results and Discussion

1. Plant Height

Drip irrigation treatment did not influence plant height of Amaranth at 1-4 WAP (Weeks after Planting), Green bean at 1-5 WAP, and katuk at 1-7 WAP. However, with drip irrigation, plant height of Kangkong at 1 – 4 WAP was higher than without drip irrigation. The same result occurred in Yard-long bean, with drip irrigation increasing plant height at 1–5 WAP (Table 2).

Table 2. Effect of Drip Irrigation on Plant Height of Amaranth, Kangkong, Yardlong Bean, Green Bean and Katuk

Treatment	WAP	Plant Height (cm)						
		Amaranth	Kangkong		Yard-long Bean		Green Bean	Katuk
Drip-Irrigation	1	4.86	6.30	a	19.31	a	20.33	1.330
Non Drip-Irrigation		4.45	5.21	b	17.04	b	20.32	1.139
Respon		ns	*		*		ns	ns
Drip-Irrigation	2	6.80	8.82	a	28.96	a	30.49	5.510
Non Drip-Irrigation		6.24	7.30	b	25.56	b	30.48	5.319
Respon		ns	*		*		ns	ns
Drip-Irrigation	3	12.63	16.38	a	45.05	a	47.43	10.235
Non Drip-Irrigation		11.58	13.56	b	39.76	b	47.42	10.026
Respon		ns	*		*		ns	ns
Drip-Irrigation	4	24.29	31.51	a	67.58	a	71.15	17.487
Non Drip-Irrigation		22.27	26.07	b	60.53	b	71.13	17.216
Respon		ns	*		*		ns	ns
Drip-Irrigation	5				160.90	a	169.41	26.916
Non Drip-Irrigation					141.99	b	169.35	26.562
Respon					*		ns	ns
Drip-Irrigation	6							39.173
Non Drip-Irrigation								38.712
Respon								ns
Drip-Irrigation	7							55.091
Non Drip-Irrigation								54.506
Respon								ns

WAP : Week After Planting; **ns :** non-significant; *** :** significant at P=0.05; ****** : significant at P=0.01

2. Stem Diameter

Drip irrigation treatment had no influence on the stem diameter of Yard-long bean at 1-5 WAP , and on Green bean at 1-5 WAP. However, with drip irrigation the stem diameter of Amaranth at 1–4 WAP Kangkong at 1-4 WAP, and Katur at 1-7 WAP were higher than without drip irrigation. The effects of drip irrigation on the stem diameter of Amaranth, Kangkong, Yard-long Bean, Green Bean and Katuk are presented in Table 2

Table 3. Effect of Drip Irrigation on Stem Diameter of Amaranth, Kangkong, Yardlong Bean, Green Bean and Katuk

Treatment	WAP	Stem Diameter (cm)							
		Amaranth		Kangkong		Yardlong Bean	Green Bean	Katuk	
Drip-Irrigation	1	0,50	a	0,68	a	0,27	0,30	1.13	a
Non Drip-Irrigation		0,44	b	0,60	b	0,20	0,28	0,80	b
Respon		*		*		ns	ns	*	
Drip-Irrigation	2	0,71	a	0,98	a	0,41	0,46	1,04	a
Non Drip-Irrigation		0,64	b	0,81	b	0,37	0,43	0,97	b
Respon		*		*		ns	ns	*	
Drip-Irrigation	3	1.39	a	1.87	a	0,68	0,76	1,94	a
Non Drip-Irrigation		1.25	b	1.56	b	0,58	0,71	1,87	b
Respon		**		*		ns	ns	*	
Drip-Irrigation	4	2.71	a	3.62	a	1.04	1.16	2,94	a
Non Drip-Irrigation		2.42	b	3.08	b	0,88	1.06	2,87	b
Respon		**		*		ns	ns	*	
Drip-Irrigation	5					2.59	2.85	3,84	a
Non Drip-Irrigation						2.23	2.66	3,77	b
Respon						ns	ns	*	
Drip-Irrigation	6							4,44	a
Non Drip-Irrigation								4,37	b
Respon								*	
Drip-Irrigation	7							5,34	a
Non Drip-Irrigation								5,27	b
Respon								*	

WAP : Week After Planting**; ns :** non-significant**; * :** significant at P=0.05; ** **:** significant at P=0.01

3. Plant Yield

Low cost drip irrigation did not influence the yield of amaranth, kangkong, yard-long bean, green bean, and katuk per plant or per ha but it influenced the yield of green bean per ha. With drip irrigation green bean yield (6,418 tons/ha) was higher than without drip irrigation (6,358 tons/ha). The high rainfall during the experiment in the experimental site accounted for the LCDS not being effective. To obtain significant response of vegetables to the LCDS, a similar treatment needs to be evaluated during the dry season.

Table 4. Effect of treatment on vegetable yield per plant and vegetable yield per ha

Plant	Treatment	Yield per plant (kg)	Yield per Ha (ton)
Amaranth	Drip-Irrigation	2,141	4,208
	Non Drip-Irrigation	2,222	4,232
	Respon	ns	ns
Kangkong	Drip-Irrigation	3,500	3,734
	Non Drip-Irrigation	3,108	3,990
	Respon	ns	ns
Yard-long bean	Drip-Irrigation	12,623	5,374
	Non Drip-Irrigation	11,159	5,182
	Respon	ns	ns
Green bean	Drip-Irrigation	15,068	6,418
	Non Drip-Irrigation	15,372	6,358
	Respon	ns	*
Katuk	Drip-Irrigation	14,148	7,300
	Non Drip-Irrigation	14,216	7,123
	Respon	ns	ns

ns : non-significant; ***** **:** significant at P=0.05; ****** : significant at P=0.01

Conclusions

This experiment shows that low cost drip irrigation did not influence the plant height of amaranth, green bean, and katuk, as well as the stem diameter of yard-long bean and green bean. Low cost drip system was also not effective to support vegetable yield during wet season.

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