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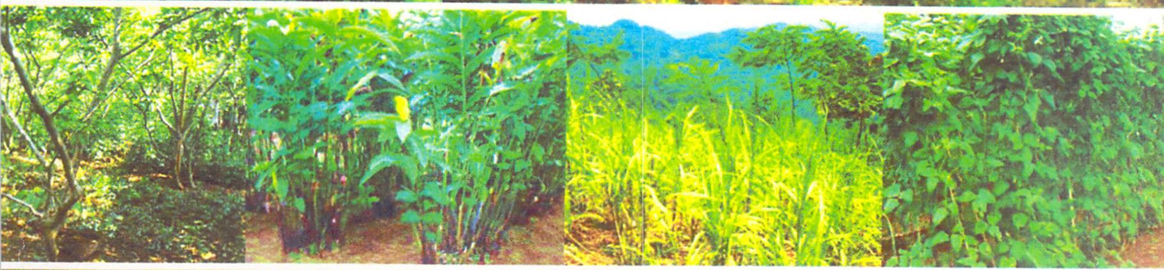
# Vegetable-Agroforestry Systems in Indonesia



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# 8. Drip Irrigation: Will It Increase Yield in Traditional Vegetable Production System?

**Anas D. Susila[1], Tisna Prasetyo[1] and Manuel C. Palada[2]**

## 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 increase 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.), kangkung (*Ipomoea aquatica*), yard-long bean (*Vigna unguiculata*), green bean (*Phaseolus vulgaris*), and katuk (*Sauropus androgynous*) growth and yield during the 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's field as one replication). The result showed no significant response of vegetable yield to the drip irrigation application during the 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, Ultisols

## 1. 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 a serious problem, even in the humid tropics, particularly in the dry season (AVRDC, 2004).

[1]Plant Production Division, Department of Agronomy and Horticulture, Faculty of Agriculture, Bogor Agricultural University, Jl. Meranti, Komplek IPB Darmaga, Bogor 16680, Indonesia. anasdsusila@ipb.ac.id, tisnaprasetyo@yahoo.com, Tel/Fax: 0251 629353

[2]Crop and Ecosystems Management Unit AVRDC-World Vegetable Center. P.O. Box 42, Shanhua, Tainan 74199, Taiwan. mpalada@gmail.com

In the rainfed production 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 reduces the potential risk to the environment due to enrichment of surface and groundwater (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, yard-long 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 averaging about 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 labor-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.), kangkung (*Ipomoea aquatica*), yard-long bean (*Vigna unguiculata*), green bean (*Phaseolus vulgaris*) and katuk (*Sauropus androgynous*) during the wet season.

## 2. Materials and Methods

The experiment was conducted at Hambaro village, Nanggung, Bogor, Indonesia, from January to May 2008 (wet season), in which the soil type was Ultisols, which typically has low pH and high P-fixation by aluminum. 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 a 1.5 x 5 m plot. The crop management practices for each vegetable can be seen in Table 1.

Measurements of plant height and diameter were conducted for kangkung 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 kangkung and amaranth, total fruit weight per plant and per plot were measured for yard-long bean and green bean. Katuk yield was measured by measuring the weight of shoots per plant and per plot. Analysis of variance data was calculated using SAS 8.12 (SAS Institute, 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 | $\sum$ seed / hole | Fertilizer |
|---|---|---|---|---|---|
| 1. | Kangkung | LwLiang Local | 25 x 15 cm | 10 | 185 kg/ha urea<br>375 kg/ha SP-36<br>225 kg/ha KCl |
| 2. | Yard-long bean | 777 | 25 x 30 cm | 2 | 185 kg/ha urea<br>375 kg/ha SP-36<br>225 kg/ha KCl |
| 3. | Green bean | Kencana | 25 x 30 cm | 2 | 126 kg/ha urea<br>250 kg/ha SP-36<br>180 kg/ha KCl |
| 4. | Amaranth | Local | row x 20 cm (four rows/bed) | Spread in rows | 112 kg/ha urea<br>250 kg/ha SP-36<br>180 kg/ha KCl |
| 5. | Katuk | aksesi Tegalwaru Ciampea | 15 x 10 cm | 1 transplant | 100 kg/ha urea<br>100 kg/ha SP-36<br>135 kg/ha KCl |

## 3. Results and Discussion

### 3.1 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 kangkung 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, kangkung, yard-long 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 | |
| Response | | 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 | |
| Response | | 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 | |
| Response | | 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 | |
| Response | | ns | | * | | * | | ns | | ns | |
| Drip-Irrigation | 5 | | | | | 160.90 | a | 169.41 | | 26.916 | |
| Non Drip-Irrigation | | | | | | 141.99 | b | 169.35 | | 26.562 | |
| Response | | | | | | * | | ns | | ns | |
| Drip-Irrigation | 6 | | | | | | | | | 39.173 | |
| Non Drip-Irrigation | | | | | | | | | | 38.712 | |
| Response | | | | | | | | | | ns | |
| Drip-Irrigation | 7 | | | | | | | | | 55.091 | |
| Non Drip-Irrigation | | | | | | | | | | 54.506 | |
| Response | | | | | | | | | | ns | |

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

### 3.3 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, kangkung at 1-4 WAP, and katuk at 1-7 WAP were higher than without drip irrigation. The effects of drip irrigation on the stem diameter of amaranth, kangkung, yard-long bean, green bean and katuk are presented in Table 3.

**Table 3.** Effect of drip irrigation on stem diameter of amaranth, kangkung, yard-long 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 |
| Response | | * | | * | | 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 |
| Response | | * | | * | | 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 |
| Response | | ** | | * | | 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 |
| Response | | ** | | * | | ns | | ns | | * | |
| Drip-Irrigation | 5 | | | | | 2.59 | | 2.85 | | 3.84 | a |
| Non Drip-Irrigation | | | | | | 2.23 | | 2.66 | | 3.77 | b |
| Response | | | | | | ns | | ns | | * | |
| Drip-Irrigation | 6 | | | | | | | | | 4.44 | a |
| Non Drip-Irrigation | | | | | | | | | | 4.37 | b |
| Response | | | | | | | | | | * | |
| Drip-Irrigation | 7 | | | | | | | | | 5.34 | a |
| Non Drip-Irrigation | | | | | | | | | | 5.27 | b |
| Response | | | | | | | | | | * | |

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

### 3.4 Plant yield

Low-cost drip irrigation did not influence the yield of amaranth, kangkung, yard-long bean, green bean, and katuk per plant or per ha but it influenced the yield of green bean per ha (Table 4). With drip irrigation green bean yield (6.418 tons/ha) was higher than without drip irrigation (6.358 ton/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 |
| | Response | ns | ns |
| Kangkung | Drip irrigation | 3.500 | 3.734 |
| | Non-drip irrigation | 3.108 | 3.990 |
| | Response | ns | ns |
| Yard-long bean | Drip irrigation | 12.623 | 5.374 |
| | Non-drip irrigation | 11.159 | 5.182 |
| | Response | ns | ns |
| Green bean | Drip irrigation | 15.068 | 6.418 |
| | Non-drip irrigation | 15.372 | 6.358 |
| | Response | ns | * |
| Katuk | Drip irrigation | 14.148 | 7.300 |
| | Non-drip irrigation | 14.216 | 7.123 |
| | Response | ns | ns |

Note: ns=non-significant, *significant at P=0.05, **significant at P=0.01

## 4. 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 irrigation system was also not effective to support vegetable yield during the wet season.

## 5. Acknowledgments

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**Appendix 1.** General views of the experimental site