Vegetables Production with *Polyethylene* Mulched and Drip Irrigation System

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Abstract

Eggplant, Yard Long Bean, and Kangkong, were grown with polyethylene mulched and drip irrigation system on Podzolic soil with low pH (4.5), low C-Organic (0.97%), very low N-total (0.17 %), low K content (0.15 me/100 g), but high soil P_2O_5 concentration (13.7 ppm) to evaluate the best crop management practices. Combination of polyethylene mulched (with and without), fertilizer application (with and without), number of irrigation line (0, 1, and 2 lines), methods of fertilizer application (preplant, split, and drip) were arranged in Randomized Completely Block Design with four replications. The result showed that mulched and fertilizer application significantly increased yield of all crops. One line irrigation system also obtained the best yield. Application of fertilizer 100% P, 50% N and K applied preplant with 50% N and K fertigated 10 times weekly was the best methods to produce Eggplant, Yard Long Bean, Kangkong under polyethylene mulched and drip irrigation system.

INTRODUCTION

In Indonesia, vegetables were planted with irrigation system or rain-fed. However, in Tenjo area most vegetable were planted with rain-fed only. Therefore, vegetables crop usually can be grown on wet season (> 200 mm/month) between Decembers – April. During dry season (<200 mm/month) between May – October, vegetables' farmers have serious problem in water availability.

Drip irigation systems have the highest potential water application efficiency of the irrigation system used in commercial vegetables production. Filed studies have shown a significant decrease in irrigation requirements of tomatoes with the use of drip irrigation system ad compared to sub irrigation system. Marketable yield, fruit size, and fruit quality were comparable and some cases better with the use of drip irrigation than sub irrigation (Pitts and Clark, 1991). Locascio et al. (1985) showed that when fertilizer was applied through the drip system, yields were higher than with fertilizer applied only before planting. 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 (Hochmuth, 1992).

Polyethylene (Black-Silver) mulched was increasingly adopted by Indonesian vegetables farmer. Some advantages of polyethylene mulched include

controlling weeds, soil temperature and humidity, fertilizer and water loss. Voss et al. (1992) showed that using polyethylene mulched increased yield of Chili pepper from 0.8 to 3.4 tons/ha in dry season, and 2.5 to 4.9 tons/ha in wet season compared with no mulched.

Combination between drip irrigation and polyethylene mulched become advanced technology (non conventional technology) to produce high quality vegetable. This technology may become good practices to solve water shortage in Tenjo area. However, the best management practices of this technology need to be verified and established before adopted by farmers. The objective of this experiment is to find out the best methods to grow some vegetables under polyethylene mulched with drip irrigation system.

MATERIAL AND METHODS

Research was carried out at the Tenjo Demo Farm, Tenjo area, Bogor Regency from April to November 2004. Pre fertilizer soil samples were taken with a soil probe from the top 15 cm of a *Podzolic* soil type. Fertilizer was applied at 117-41-131 kg N-P2O5-K2O·ha^{-1} from Urea SP36 and potassium sulfate. All the P and 50 % of N and K applied preplant, and 50 % of N and K were fertigated

Treatments were Mulch + No Line + 100% Preplant (P1), Mulch + No line + No Fertilizer (P2), Mulch + 1line+ 100% Preplant (P3), Mulch + 1 line + Split (P4), Mulch + 1 line + Drip (P5), Mulch + 2 lines 100% Preplant, (P6), Mulch + 2 lines + Split (P7), Mulch + 2 lines + Drip (P8), No mulch + no lines + 100% preplant. Treatments were arranged in Randomized Completely Block design with four replications

Preplant applications were applied of fertilizer broadcast and rototilled into raised bed approximately 0.9 m wide and 20 cm high. Drip applications were applied 10 times weekly, and split applications were 50% preplant and 50% drip

Dripper line an irrigation tubing (orifice diameter, 0.025 cm; emitter spacing, 20 cm; rate of 1.7 liter hours) was placed on the soil surface at 10 cm from the bed center and covered with black polyethylene mulch (Sonoco with 0.0038 cm thickness). Vegetables crop used in this experiment were Eggplant (*Solanum melongena*) var. Ungu, Kangkong (*Ipomoea reptans)* var Sutera, and Yard Long Bean (*Vigna unguilata*) var. putih panjang. Eggplants were spaced 0.6 m within row and 0.6 between rows (double rows). Yard long bean were spaced 0.25 m within row and 0.6 between rows (double rows). Kangkong were spaced 0.1 m within row and 0.25 between rows (four rows). The irrigation was applied 2 times per day (9 a.m. and 2 p.m.) each of 30 minutes running or about 21.25 liter per plot (5 square meters). Irrigation was applied if there was no rain.

Observation were marketable, non marketable, and total yield of Eggplant, Yard Long Bean, and Kangkong. Analysis of variance of data was calculated using SAS 6.12 (SAS Institute, N.C). Orthogonal contrast were used to compare mulch (no mulch *vs* with mulch), number of line (no line *vs* 1 line, no line *vs* 2-lines, 1 line *vs* 2 lines), and fertilizer application (no fertilizer *vs* with fertilizer).

RESULT AND DISCUSSION

Soil Analysis

Soil analysis showed that soil pH (water) at the experimental area was very low (4.5). It was common situation for *Podzolic* soil type. Therefore, Dolomitic lime was

applied to increase soil pH to 6-6.5 unit. C-Organic content was 0.97% (low), N total 0.17 % (very low), and C/N ratio of 6 (consider very low). To improved soil fertility especially for organic content, manure was applied at 20 tons.ha^{-1}. Soil P_2O_5 concentration (Bray 1) was 13.7 ppm (high) and K (NH_4 Acetate 1N, pH 7) was 0.15 me/100 g (low).

Eggplant (*Solanum melongena*)

The effect of mulch on eggplant was significant for all measured variable except on non-marketable yield. By mulching, marketable yield increased from 6 654 g to 15 461 g per plot (Table 1). Total yield also increased almost two and half times by using polyethylene mulch. Without mulch percentage of non-marketable yield increased. This result shows that under polyethylene mulch soil environment condition became more appropriate to support eggplant growth than without mulch on the upland area. Polyethylene mulch can reduce water loss from soil evaporation.

Number of irrigation line was significantly influenced marketable yield and total yield per plot. However, number of line was not influenced non-marketable yield, percentage of marketable yield, and percentage of non-marketable yield (Table 2). The highest total yield and marketable yield were obtained with one irrigation line, these were 18 746.6 g per plot and 17 620.1 g per plot, respectively. With one irrigation line, marketable yield and total yield significantly higher than with no irrigation. However, with one irrigation line was not significant compared with two lines for marketable yield. The data showed that with drip irrigation line percentage of marketable yield was increased.

The effect of fertilizer significantly increased total marketable yield, but did not influence marketable yield of eggplant. Increasing in total yield from 12 076.5 g per plot to 15 85.2 g per plot by fertilizer application indicate that the soil fertility relatively low (Table 3). Therefore, optimizing fertilization program through drip irrigation and polyethylene mulched system for this experimental area still need to be conducted to produce eggplant.

Preplant application of 100 % N and K significantly reduced marketable yield and total yield per plot (Table 4). Fertilizer application of N and K 100% through drip system obtained higher marketable yield and total yield than 100% preplant. However, this result was not significant with split application where 50% of N and K applied preplant and 50% applied 10 times weekly.

Yard Long Bean (*Vigna unguilata*)

The effect of mulch on yard long bean was significant for all measured variable. By mulching, marketable yield increased from 202 g to 692 g per plot (Table 5). Total yield also increased three times by using mulch, from 230.5 g per plot to 700.9 g per plot. However weight of unmarketable weight decease significantly from 28.5 g per plot to 8.1 g per plot with polyethylene mulched. Without mulch percentage of non-marketable yield increased. This result shows that under polyethylene mulch soil environment condition became more appropriate for yard long bean to grow than without mulch.

Number of irrigation line was significantly influenced marketable yield and total yield per plot. However, number of line was not influenced percentage of marketable yield, and percentage of non marketable yield (Table 6). The highest total yield and marketable yield were obtained with one irrigation line; these are

906.2 g per plot and 899.4 g per plot, respectively. With no irrigation line marketable yield and total yield significantly lower than with two irrigation line. However, with no irrigation line was not significant with one line for marketable yield and total yield. Two irrigation lines was significantly obtained higher marketable and total yield than one line. Therefore, two irrigation lines under polyethylene mulched was best choice for yard long bean production.

The effect of fertilizer significantly increased marketable yield and total yield. Increasing in total yield from 228.8g per plot to 701.1 g per plot indicated that the soil fertility was low for growing of yard long bean (Table 7). Therefore, optimizing fertilization program through drip irrigation and polyethylene mulched system for yard long bean in this experimental area still need to be find out.

Preplant application of 100 % N and K significantly reduced marketable yield and total yield per plot of yard long bean (Table 8). The lowest marketable yield and total yield per plot were obtained by preplant application. Preplant application was different with Split and Drip application for both previous variable. Fertilizer application of 50% of N and K applied preplant and 50% applied 10 times weekly (split application) obtained the highest marketable yield and total yield compared preplant application and drip application where N and K 100% applied through drip. In split application, 50% preplant is needed for support initial growth of yard long bean. It was better rather than 100 fertilizer applied preplant or 100% fertigated 10 times weekly. Similar result reported by Susila and Locascio (2001), that 40% S fertilizer applied preplant and 60% injected obtained better yield of cabbage than 100% applied preplant.

Kangkong (*Ipomoea reptans*)

Similar result with eggplant and yard long beans, the effect of mulch on Kangkong was significant for marketable yield. By mulching, marketable yield increased from 1,151.3 g to 3,059.7 g per plot (Table 9).

Number of irrigation line was significantly influenced marketable per plot of Kangkong (Table 9). The highest total yield marketable yield were obtained with one irrigation line, these are 3,689.0 g per plot. With no irrigation line, marketable yield was lower than with one or two irrigation line. However, was not significant different between one line and two line for marketable yield. Therefore, one irrigation line under polyethylene mulched was enough to support kangkong growth and yield.

The effect of fertilizer significantly increased marketable yield of Kangkong. Increasing in total yield from 890.0 g per plot to 3,092.3 g per plot indicate that the soil fertility was too low for support Kangkong growth (Table 9). Preplant application of 100 % N and K significantly reduced marketable yield of Kangkong (Table 9). The lowest marketable yield and per plot was obtained by preplant application, followed by drip, and split application. Fertilizer application of 50% of N and K applied preplant and 50% applied 10 times weekly (split application) obtained the highest marketable yield and total yield compared preplant application and drip application where N and K 100% through drip.

CONCLUSION

From this experiment, it can be concluded that:

1. Soil fertility status of the experimental area need to be improved due to contain low pH (4.5), low C-Organic (0.97%), very low N-total (0.17 %), low K content (0.15 me/100 g), but high soil P_2O_5 concentration (13.7 ppm).
2. Polyethylene mulch increased yield of eggplant, yard long bean, Kangkong.
3. Fertilizer application increased yield of eggplant, yard long bean, Kangkong.
4. One line irrigation system obtained the best yield for eggplant, Kangkong, but for yard long bean, two lines was the best system.
5. Split fertilizer application methods system obtained the best yield for eggplant, yard long bean, Kangkong.

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Tables

Table 1. The effect of mulch on marketable and non marketable yield of Eggplant

Treatments	Marketable Yield Per Plot (g)	Unmarketable Yield Per Plot (g)	Total Yield Per Plot (g)	Percent Marketable Yield	Percent Non Marketable Yield
No Mulch	6654.0	801.3	7455.3	90.1	9.9
Mulch	15461.4	901.5	16362.9	94.6	5.4
Contrast	**	**NS**	**	**	**

** = Significant at 0.01 probability level , NS = Not Significant at P>0.05

Table 2. The effect of number of irrigation line on marketable and non marketable yield of Eggplant

Treatments	Marketable Yield Per Plot (g)	Unmarketable Yield Per Plot (g)	Total Yield Per Plot (g)	Percent Marketable Yield	Percent Non Marketable Yield
No Line (Check)	9422.0	683.5	10105.5	93.8	6.2
One Line	17620.1	1126.5	18746.6	94.2	5.8
Two Line	16679.1	814.7	17493.8	95.4	4.6
Contrast					
No Line Vs 1 Line	**	**NS**	*	**NS**	**NS**
No Line Vs 2 Line	*	**NS**	*	**NS**	**NS**
1 Line Vs 2 Line	**NS**	**NS**	*	**NS**	**NS**

*,** = Significant at 0.05 and 0.01 probability level, respectively, NS = Not Significant at P>0.05

Table 3. The effect of fertilizer on marketable and non marketable yield of Eggplant

Treatments	Marketable Yield Per Plot (g)	Unmarketable Yield Per Plot (g)	Total Yield Per Plot (g)	Percent Marketable Yield	Percent Non Marketable Yield
No Fertilizer	11371.8	704.8	12076.5	94.0	6.0
Fertilizer	14871.7	913.5	15785.2	94.1	5.9
Contrast	**NS**	*	*	**NS**	**NS**

*= Significant at 0.05 probability level, NS = Not Significant at P>0.05

Table 4. The effect of fertilizer application methods on marketable and non marketable yield of Eggplant

Treatments	Marketable Yield Per Plot (g)	Unmarketable Yield Per Plot (g)	Total Yield Per Plot (g)	Percent Marketable Yield	Percent Non Marketable Yield
Preplant	14212.8	878.5	15091.3	94.4	5.6
Drip	19005.1	913.3	19918.4	95.9	4.1
Split	18230.9	1120.0	19350.9	94.1	5.9
Contrast					
Preplant Vs Drip	**NS**	**NS**	**NS**	**NS**	**NS**
Preplant Vs Split	**	**NS**	**	**NS**	**NS**
Drip Vs Split	**	**NS**	**	**NS**	**NS**

** = Significant at 0.01 probability level, NS = Not Significant at P>0.05

Table 5. The effect of mulch on marketable and non marketable yield of Yard-long bean

Treatment	Marketable Yield Per Plot (g)	Unmarketable Yield Per Plot (g)	Total Yield Per Plot (g)	Percent Marketable Yield	Percent Non Marketable Yield
No Mulch	202.0	28.5	230.5	88.7	13.5
Mulch	692.8	8.1	700.9	98.3	2.3
Contrast	**	*	**	**	**

*,** = Significant at 0.05 and 0.01 probability level, respectively

Table 6. The effect of number of irrigation line on marketable and non marketable yield of Yard-long bean

Treatments	Marketable Yield Per Plot (g)	Unmarketable Yield Per Plot (g)	Total Yield Per Plot (g)	Percent Marketable Yield	Percent Non Marketable Yield
No Line (Check)	368.8	3.5	372.3	98.7	2.7
One Line	753.3	9.3	762.6	98.7	2.3
Two Line	899.4	6.8	906.2	99.3	0.7
Contrast					
No Line Vs 1 Line	**NS**	**NS**	**NS**	**NS**	**NS**
No Line Vs 2 Line	*	**NS**	*	**NS**	**NS**
1 Line Vs 2 Line	**	**NS**	**	**NS**	**NS**

*,** = Significant at 0.05 and 0.01 probability level, respectively , NS = Not Significant at P>0.05

Table 7. The effect of fertilizer on marketable and non marketable yield of Yard-long bean

Treatments	Marketable Yield Per Plot (g)	Unmarketable Yield Per Plot (g)	Total Yield Per Plot (g)	Percent Marketable Yield	Percent Non Marketable Yield
No Fertilizer	216.0	12.8	228.8	94.0	7.0
Fertilizer	691.1	10.0	701.1	97.7	3.2
Contrast	**	**NS**	**	**NS**	**NS**

** = Significant at 0.05 probability level, NS = Not Significant at P>0.05

Table 8. The effect of fertilizer application methods on marketable and non marketable yield of Yard-long bean

Treatments	Marketable Yield Per Plot (g)	Unmarketable Yield Per Plot (g)	Total Yield Per Plot (g)	Percent Marketable Yield	Percent Non Marketable Yield
Preplant	749.3	5.1	754.4	99.3	1.0
Drip	737.4	9.4	746.8	98.6	2.5
Split	992.4	9.6	1002.0	99.1	1.1
Contrast					
Preplant Vs Drip	**NS**	**NS**	**NS**	**NS**	**NS**
Preplant Vs Split	**	**NS**	**	**NS**	**NS**
Drip Vs Split	**	**NS**	**	**NS**	**NS**

** = Significant at 0.01 probability level , NS = Not Significant at P>0.05

Table 9. The effect of mulch, number of irrigation line, fertilizer, and fertilizer application methods on marketable yield of Kangkong

Treatments	Marketable Yield Per Plot (g)
	Mulch
No Mulch	1151.3
Mulch	3059.7
Contrast	**
	Number of Irrigation Line
No Line (Check)	1878.8
One Line	3689.0
Two Line	3547.3
Contrast	
No Line Vs 1 Line	*
No Line Vs 2 Line	*
1 Line Vs 2 Line	**NS**
	Fertilizer
No Fertilizer	890.0
Fertilizer	3093.3
Contrast	**
	Fertilizer Application Methods
Preplant	2883.8
Drip	3484.6
Split	4486.0
Contrast	
Preplant Vs Drip	*
Preplant Vs Split	**
Drip Vs Split	**

*,** = Significant at 0.05 and 0.01 probability level, respectively , NS = Not Significant at P>0.05