

Growth and yield responses of four leafy vegetables to organic fertilizer

(Tindak balas pertumbuhan dan hasil empat jenis sayur daun terhadap baja organik)

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Keywords: organic fertilizer, poultry manure, inorganic fertilizer, leaf mustard, lettuce, chinese spinach, kangkung

Abstract

Four leafy vegetables, namely, leaf mustard (*Brassica juncea*), kangkung (*Ipomoea reptans*), chinese spinach (*Amaranthus* sp.) and lettuce (*Latuca sativa*), were grown on a clay loam soil with increasing rates of poultry manure (0, 10, 20, 30 and 40 t/ha), with and without inorganic fertilizer. There were altogether ten treatments. The rate of inorganic fertilizer (N:P₂O₅:K₂O:MgO = 12:12:17:2) applied was 1 t/ha. The mean plant height of leaf mustard increased from 19.6 cm at 24 days after sowing (DAS) to 39.2 cm at 32 DAS and the mean leaf number was 6.7 and 9.7 respectively. The mean yield was 5.5 kg/plot and 337.7 g/plant. For kangkung, the mean plant height was 33.1 cm at 22 DAS and 46.7 cm at 29 DAS, and the mean yield was 6.2 kg/plot and 156.2 g/plant. Height of chinese spinach at 22 DAS and 29 DAS was 36.8 cm and 66.7 cm respectively with a mean yield of 7.2 kg/plot and 188.2 g/plant. Lettuce gave a mean height of 20.8 cm for both 48 DAS and 54 DAS. Its mean leaf number was 11.0 at 38 DAS, 31.2 at 48 DAS and 32.1 at 54 DAS, with a mean yield of 6.6 kg/plot and 164.0 g/plant. For most of the vegetables, application of 10 t/ha poultry manure (PM) gave lower yields than inorganic fertilizer alone. Generally, 20 t/ha PM gave comparable yields to inorganic fertilizer alone. The optimum yields obtained for leaf mustard, kangkung, chinese spinash and lettuce were 19.9, 24.1, 29.6 and 24.0 t/ha respectively. The yields resulted from optimum application of organic fertilizer at 28.75 t/ha (leaf mustard), 29.79 t/ha (kangkung), 35.98 t/ha (chinese spinash) and 29.92 t/ha (lettuce).

Introduction

Leaf mustard (*Brassica juncea*), kangkung (*Ipomoea reptans*), chinese spinach (*Amaranthus* sp.) and lettuce (*Latuca sativa*) are popular leafy vegetables in Malaysia occupying land areas of 3,008 ha, 2,698 ha, 2,297 ha and 904 ha respectively (DOA 2006). Generally, both organic and inorganic fertilizers are used for the cultivation of

vegetables. With the escalating interest in organic vegetable cultivation due to its health and environmental benefits both locally and globally, intensified research on all aspects of organic farming is timely and urgent. Several studies have been conducted to evaluate the efficacy of organic nutrient sources and rates on vegetable yields (Vimala et al. 2000a; Vimala et al.

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2000b; Vimala et al. 2001; Vimala et al. 2004; Vimala et al. 2006; Vimala et al. 2007; Vimala et al. 2010). Organic nutrient sources have been reported to improve vegetable quality (Stoffella et al. 2003; Pavla and Pokluda 2008) and soil chemical, physical and biological properties (Berry et al. 2003; Vimala et al. 2006; Sanwal et al. 2006; Vimala et al. 2007; Chan et al. 2008). Recently, Ghorbani et al. (2008) reported that the application of poultry manure resulted in lower disease incidence compared to other organic and inorganic amendments. Soil N and P contents were found to be higher with poultry litter compared to several other organic nutrient sources (Gagnon and Simard 1999).

This study investigated the growth and yield responses of four leafy vegetables to poultry manure (PM) and PM + inorganic fertilizers (IF) with the objective of obtaining optimum rates of PM for organic cultivation of leafy vegetables and to determine yield reduction, if any, with organic fertilizer as the sole nutrient source.

Materials and methods

Field details

Poultry manure (PM) at 0, 10, 20, 30 and 40 t/ha with and without inorganic fertilizer (IF) were evaluated on four leafy vegetables grown on clay loam soil. The physical and chemical properties of the soil are presented in *Table 1*. A control treatment, without organic and inorganic fertilizers was included. There were altogether 10 treatments, as in *Table 2*. The treatments were arranged in randomized complete block design with three replicates. The leafy vegetables evaluated were leaf mustard, kangkung, chinese spinach and lettuce.

The organic fertilizer (PM) was applied as basal about a week before sowing/transplanting and worked into the soil. The nutrient content and amounts of PM at 10, 20, 30 and 40 t/ha are presented in *Table 3*. Leaf mustard was transplanted to the field plots from nursery trays at 12 days after sowing (DAS), chinese spinach at 10

DAS and lettuce at 23 DAS. Kangkung seeds were sown directly into the soil. Plot size used was 2 m x 1 m and the planting distance was 20 cm x 20 cm to give 40 plants/plot.

For the PM + IF treatments, a compound fertilizer (N:P₂O₅:K₂O:MgO = 12:12:17:2 +Te) was applied at 1 t/ha, in two split applications at one week (1st top) and three weeks (2nd top) after transplanting/sowing. The compound fertilizers were applied in furrows in between the planting rows and covered with soil. The nutrient elements in the compound fertilizer applied are presented in *Table 4*.

Harvesting was at 33 DAS for leaf mustard, 35 DAS for chinese spinach, 32 DAS for kangkung and 62 DAS for lettuce. Routine agronomic practices were followed for crop management and pest control.

Table 1. Soil chemical properties

Soil properties	Values
Clay (%)	30.83
Coarse sand (%)	4.20
Fine sand (%)	35.42
Silt (%)	28.33
N (%)	0.11
P (%)	0.14
Soluble P (ppm)	252.00
CEC (cmol(+)kg ⁻¹)	10.89
Ex. Ca (cmol(+)kg ⁻¹)	5.39
Ex. K (cmol(+)kg ⁻¹)	0.43
Ex. Mg (cmol(+)kg ⁻¹)	1.66
Base Saturation (%)	68.68
Organic carbon (%)	1.21

Table 2. List of treatments

Treatment no.	Poultry manure (PM) t/ha	Inorganic fertilizer (IF) t/ha
1	10	0
2	10	1
3	20	0
4	20	1
5	30	0
6	30	1
7	40	0
8	40	1
9	0	1
10	0	0

Table 3. Nutrient content of poultry manure (PM)

Nutrient	Content	Nutrient amounts in the four organic rates applied (kg)			
		10 t/ha	20 t/ha	30 t/ha	40 t/ha
Macronutrient (%)					
N	1.80	180	360	540	720
P	2.86	286	572	858	1144
K	2.54	254	508	762	1016
Ca	13.3	1330	2660	3990	5320
Mg	1.09	109	218	327	436
Micronutrient (ppm)					
Mn	591	5.91	11.82	17.73	23.64
Fe	2014	20.14	40.28	60.42	80.56
Cu	53	0.53	1.06	1.59	2.12
Zn	489	4.89	9.78	14.67	19.56
B	29	0.29	0.58	0.87	1.16

Table 4. Nutrients in compound fertilizer

Nutrient	Content (%)	Nutrients in one tonne compound fertilizer (kg)
N	12	120
P	5.28	52.8
K	14.1	141
Mg	1.2	12

Data recording

Plant height was measured at intervals starting at 24 days after sowing (DAS) for leaf mustard, 22 DAS for kangkung and chinese spinach, and 48 DAS for lettuce. Leaf number was counted for leaf mustard and lettuce only. Fresh yield and plant number at harvest were recorded for all the vegetables.

Statistical analysis

Data obtained were subjected to statistical analysis using analysis of variance procedures to test the significant effect of all the variables investigated. Means were separated by the least significant difference (LSD) method using SAS statistical package. Regression analysis was used to obtain the optimum rate of organic fertilizer.

Results and discussion

Plant height

Plant height at various stages of growth is presented in *Table 5* for leaf mustard, kangkung, chinese spinach and lettuce.

Leaf mustard The height of leaf mustard at 24 DAS ranged from 16.9 to 21.3 cm. Plant height at 30 t/ha PM + IF (21.3 cm) was significantly higher than the control (16.9 cm). At 32 DAS the height ranged from 28.8 cm to 42.5 cm and did not differ significantly except for the control. For the tallest plants at 32 DAS (42.5 cm), the increase in height from 24 DAS (20.6 cm) was 21.9 cm or 2.7 cm/day. It can be concluded that the various fertilizer rates, except for the control, did not have much influence on the height of leaf mustard.

Kangkung The height of kangkung at 22 DAS ranged from 23.4 cm to 37.3 cm and there were no significant differences between treatments, except for the control. There was rapid growth between 22 DAS and 29 DAS and at the latter date, plant height ranged from 32.3 cm to 50.1 cm. For the tallest plants at 29 DAS (50.1 cm) the height increase from 22 DAS (35.7 cm) was 14.4 cm or 2.1 cm/day. There were, however, no significant differences between

Responses of leafy vegetables to organic fertilizer

Table 5. Plant height (cm) of vegetables fertilized with various rates of organic (PM) and inorganic (IF) fertilizers at various stages (days after sowing)

Fertilizer treatments (t/ha)		Leaf mustard		Kangkung		Chinese spinach		Lettuce	
PM	IF	24	32	22	29	22	29	48	54
10	0	20.2ab	36.4a	33.7a	49.2a	41.2a	74.5a	26.2a	26.4a
10	1	20.6ab	42.5a	33.1a	45.0a	36.3ab	68.6a	19.0abcd	19.2abcd
20	0	20.1ab	42.0a	35.9a	47.3a	40.6a	69.2a	21.6abc	21.8abc
20	1	20.5ab	42.2a	35.3a	49.1a	39.8a	65.2a	25.1ab	23.6abc
30	0	19.2ab	37.8a	34.0a	49.3a	44.8a	70.9a	21.6abc	21.7abc
30	1	21.3a	41.9a	35.7a	50.1a	41.6a	74.0a	24.8ab	25.1ab
40	0	18.9ab	39.7a	37.3a	49.8a	38.3a	67.5a	24.4ab	24.5ab
40	1	17.8ab	40.0a	31.2ab	47.0a	31.7ab	63.7a	17.5bcd	17.7bcd
0	1	20.5ab	40.7a	31.1ab	48.1a	32.0ab	69.5a	15.5cd	15.7cd
0	0	16.9b	28.8b	23.4b	32.3b	21.8b	43.8b	12.5d	12.6d
Mean		19.6	39.2	33.1	46.7	36.8	66.7	20.8	20.8
Significance		**	**	*	*	*	**	**	*
CV (%)		10.9	10.5	14.9	13.2	23.5	9.5	19.1	19.9

PM = Poultry manure; IF = Inorganic fertilizer

*significant at $p < 0.05$; **significant at $p < 0.01$

Column means with the same letter (s) are not significantly different

Table 6. Leaf number of leaf mustard and lettuce fertilized with various rates of organic (PM) and inorganic (IF) fertilizers at various growth stages (days after sowing)

Fertilizer treatments (t/ha)		Leaf mustard		Lettuce		
PM	IF	24	32	38	48	54
10	0	6.3bc	9.7ab	12.8ab	39.5a	40.5a
10	1	6.5bc	9.8ab	11.5abc	28.8bc	29.7bc
20	0	7.2ab	10.3a	11.5abc	32.5ab	33.3abc
20	1	5.8c	9.3ab	13.7a	37.2ab	38.2ab
30	0	7.2ab	9.5ab	12.5ab	35.3ab	36.2ab
30	1	6.8abc	11.0a	11.8ab	32.8ab	33.8ab
40	0	7.8a	10.5a	10.3abc	33.8ab	34.8ab
40	1	6.7abc	9.7ab	9.0bc	28.5bc	29.5bc
0	1	6.2bc	9.5ab	9.3bc	23.8cd	24.8cd
0	0	6.3bc	8.0b	7.5c	19.2d	19.8d
Mean		6.7	9.7	11.0	31.2	32.1
Significance *		*	*	**	**	
CV (%)		9.6	10.6	19.2	14.6	14.7

PM = Poultry manure; IF = Inorganic fertilizer

*significant at $p < 0.05$; **significant at $p < 0.01$

Column means with the same letter (s) are not significantly different

the treatments, with the exception of the control treatment, which received no organic or inorganic fertilizer. It appears that the various fertilizer rates did not have much effect on the height of kangkung.

Chinese spinach This was the tallest of the four vegetables evaluated and the height at 22 DAS ranged from 21.8 cm to 44.8 cm. Similar to kangkung, there was rapid growth between 22 and 29 DAS, with height at the 29 DAS ranging from 43.8 cm to 74.5 cm. The tallest plants at 29 DAS (74.5 cm) showed an increase in height of 33.3 cm from 22 DAS (41.2 cm) or 4.8 cm/day, rendering chinese spinach the fastest growing of the four vegetables evaluated. At both dates, there were no significant differences in the height of the vegetables between treatments except for the control. Again it was observed that fertilizer rates with the exception of the control did not appear to influence the height of chinese spinach.

Lettuce The height of lettuce ranged from 12.5 cm to 26.2 cm at 48 DAS and from 12.6 cm to 26.4 cm at 54 DAS. Though some significant differences were obtained, no clear trend could be discerned. The lowest height was obtained with the control treatment (0 0) followed by the inorganic only treatment (0 1) and the tallest plants were obtained with 10 t/ha PM as the sole nutrient source.

Leaf number

The mean leaf number/plant is presented in *Table 6* for leaf mustard and lettuce.

Leaf mustard Leaf number at 24 DAS ranged from 5.8 to 7.8. All organic only treatments showed comparable or higher leaf number than the control and IF alone, but was generally not significantly different. At 32 DAS the leaf number ranged from 8.0 to 11.0. The PM only treatment gave comparable or higher leaf number (9.5–10.5) compared to IF alone (9.5). There were no

significant differences between PM + IF and PM only, indicating that PM as the sole nutrient source can sustain growth just as well as PM + IF.

The mean leaf number for leaf mustard at 24 DAS and 32 DAS was 6.7 and 9.7 respectively. Though there were some significant differences between treatments no clear trend could be discerned.

Lettuce The mean leaf number for lettuce increased from 11.0 at 38 DAS to 31.2 at 48 DAS, indicating rapid growth (2.1 leaves/day) during this period. The mean leaf number increased just slightly to 32.1 at 54 DAS indicating no new leaf growth and some leaf senescence. The control treatment (0 0) gave significantly lower leaf number compared to the other treatments at 48 and 54 DAS but was not significantly lower than the inorganic only treatment (0 1). All PM only treatments at 38 DAS (10.3–12.8), 48 DAS (32.5–39.5) and 54 DAS (33.3–40.5), showed higher leaf number than the IF and control treatments, indicating that using organic fertilizer alone can provide sufficient nutrients for good plant growth at all stages.

Plot yield

The mean yield/plot for the various treatments are presented in *Table 7*.

Leaf mustard Fertilizers had a significant effect on yield/plot with the highest yield (7.4 kg/plot) obtained with 30 t/ha PM and 1 t/ha IF. Generally, higher yields were obtained with poultry manure (PM) + inorganic fertilizer (IF) compared to only PM at all rates, except at 40 t/ha PM. At this highest rate of organic input, the addition of IF had a deleterious effect on yield, probably due to salt toxicity. This is not surprising, considering the large amounts of nutrients from the organic and inorganic fertilizers applied (*Tables 3–4*). It is interesting to note that PM as the sole nutrient source at 20, 30 and 40 t/ha gave higher yields (5.4–6.0 kg/plot) compared to IF alone (5.1 kg/plot), indicating that organic fertilizer as the sole

Table 7. Yield (kg/plot) of vegetables fertilized with various rates of organic (PM) and inorganic fertilizers (IF)

Fertilizer treatment (t/ha)		Leaf mustard	Kangkung	Chinese spinach	Lettuce
PM	IF				
10	0	4.6c	6.4a	5.5b	8.2a
10	1	6.6ab	6.1a	6.6ab	5.3ab
20	0	6.0abc	5.9a	7.0ab	6.7ab
20	1	6.7ab	7.7a	9.3a	8.3a
30	0	5.4bc	7.4a	9.2a	8.4a
30	1	7.4a	8.3a	9.6a	8.1a
40	0	5.7bc	6.5a	8.6ab	8.0a
40	1	5.4bc	6.5a	6.4ab	5.2ab
0	1	5.1bc	5.6a	7.2ab	4.1b
0	0	2.3d	2.1b	2.1c	3.4b
Mean		5.5	6.2	7.2	6.6
Significance		**	*	**	*
CV		15.6	25.9	25.5	28.9

PM = Poultry manure; IF = Inorganic fertilizer;

*significant at $p < 0.05$; **significant at $p < 0.01$

Column means with the same letter (s) are not significantly different

source of nutrients need not necessarily give reduced yields, as generally perceived. Though high levels of nutrients are present in 10 t/ha PM (Table 3), the low availability of nutrients from organic sources renders 10 t/ha PM insufficient for good yields of leaf mustard. Generally only 30% N, 20% P and 30–50 % K is available from organic nutrient sources (Dierolf et al. 2001). Based on these availability figures, 10 t/ha would provide only 54 kg N, 57 kg P and 76 kg K/ha which clearly are insufficient compared to the nutrients found in 1 t/ha inorganic fertilizer and the higher rates of poultry manure (Tables 3–4).

Kangkung All the fertilizer rates gave significantly higher yield/plot (5.6–8.3 kg) compared to the control (2.1 kg) but there were no significant differences among the rates. Higher yields were obtained with PM + IF compared to only IF at all rates of PM. But at 40 t/ha PM, there was no difference in yield (6.5 kg vs 6.5 kg). Poultry manure as the sole nutrient source even at 10 t/ha gave better yields (6.4 kg/

plot) than inorganic fertilizer alone (5.6 kg/plot), again indicating that organic fertilizer as the sole source of nutrients, applied at the right dosage, can give yields comparable to inorganic fertilizer (Table 7).

Chinese spinach All the fertilizer rates gave significantly higher yields (5.5–9.6 kg/plot), compared to the control (2.1 kg/plot). As expected, and similar to leaf mustard and kangkung, higher yields were obtained with PM + IF, compared to only PM at all rates of organic fertilizer, except at 40 t/ha, when the addition of IF depressed yields by 30% (Table 7). This yield reduction when IF was applied together with 40 t/ha PM is, as explained earlier, attributed to salt toxicity due to the high amounts of nutrients (Tables 3–4) from both the organic and inorganic sources. Again, 10 t/ha organic fertilizer was insufficient giving only 5.5 kg/plot compared to 7.2 kg/plot with IF alone. At 20 t/ha (20 0), PM gave comparable yields (7.0 kg) to 1 t/ha (0 1) IF (7.2 kg), further confirming that good yields can be obtained with organic sources

as the sole source of nutrients if sufficient amounts are applied. It is emphasized that in organic cultivation, the rate of organic fertilizer required can be 10 to 30 folds, or even higher, than the recommended rate of inorganic fertilizer. As discussed earlier, though high rates of organic fertilizers are required, profitable returns are possible in organic cultivation because of the premium price of organic produce, which can range from 2–4 times the price of conventional produce.

Lettuce This vegetable gave better yields with PM at all rates (6.7–8.4 kg/plot) compared to inorganic fertilizer only, and even compared to PM + IF at almost all rates of application (*Table 7*). For example, PM at 10 t/ha as the sole nutrient source gave higher yields (8.2 kg) than IF only (4.1 kg), and PM + IF at 10 t/ha (5.3 kg), 30 t/ha (8.1 kg) and 40 t/ha (5.2 kg). Previous studies (Lathiff and Maraikar 2003; Sanwal et al. 2006) too have reported comparable or higher yields of vegetables when grown with organic nutrient sources than with

chemical fertilizers. As obtained for the other vegetables, 40 t/ha PM + IF depressed yields. Using the nutrient availability data of Dierolf et al. (2001), 20 t/ha PM would provide 108 kg N, 114 kg P and 152 kg K/ha (*Table 3*). It is interesting to note that these values, with the exception of P, are comparable to the 120 kg N, 53 kg P and 141 kg K/ha provided by the application of 1 t/ha of inorganic fertilizer, underscoring the fact that yields are very much directly dependent on the nutrients available and not on the nutrients applied. As poultry manure is the most common organic source of nutrients in Malaysia it is suggested that studies on its nutrient availability be conducted.

Yield/plant

The mean yield/plant for the various treatments are presented in *Table 8*. Generally, the yield/plant showed similar treatment differences as yield/plot for all the four vegetables.

Table 8. Yield (g/plant) of vegetables fertilized with various rates of organic fertilizer with and without addition of inorganic fertilizer

Fertilizer treatment (t/ha)		Leaf mustard	Kangkung	Chinese spinach	Lettuce
PM	IF				
10	0	114.2c	160.4a	145.6b	205.4a
10	1	165.0ab	152.5a	173.1ab	131.3ab
20	0	149.6abc	147.9a	184.7ab	166.3ab
20	1	167.5ab	192.9a	243.4a	207.1a
30	0	135.4bc	185.0a	242.8a	209.6a
30	1	185.0a	206.3a	252.9a	202.9a
40	0	141.3bc	161.7a	226.4ab	200.9a
40	1	135.0bc	162.5a	167.5ab	129.2ab
	0	126.3bc	140.4a	190.4ab	103.3b
	0	57.5d	52.1b	56.2c	83.8b
Mean		137.7	156.2	188.3	164.0
Significance		**	*	**	*
CV%		15.6	25.9	25.5	28.0

PM = Poultry manure; IF = Inorganic fertilizer

*significant at $p < 0.05$; **significant at $p < 0.01$

Column means with the same letter (s) are not significantly different

Leaf mustard Significant differences were obtained between the treatments. The yield/plant ranged from 57.5g (control) to 185.0 g (30 t/ha PM + IF). Generally, at each level of PM higher yields/plant were obtained when IF was added, except at 40 t/ha. The mean yield/plant obtained was 137.7 g.

Kangkung There was no significant difference in yield/plant between any of the treatments, except for the control. The yield/plant ranged from 52.1 g to 206.3 g (30 t/ha PM + IF) and the mean yield/plant obtained was 156.2 g.

Chinese spinach Significant differences were obtained between the treatments. Yield ranged from 56.2 g (control) to 252.9 g (30 t/ha PM + IF). The mean yield obtained was 188.3 g. It is interesting to note that the yields from the control plots were similar for leaf mustard (57.5 g), kangkung (52.1 g) and Chinese spinach (56.2 g) indicating a similar ability to uptake nutrients from the soil. It is also interesting to note that the highest yields for the above three vegetables were from the same treatment i.e. 30 t/ha PM + IF.

Lettuce The yields ranged from 83.8 g (control) to 209.6 g/plant (30 t/ha PM). The mean yield was 164.0 g/plant. The control plot gave higher yields (83.8 g/plant) of lettuce compared to leaf mustard (57.5 g/plant), kangkung (52.1 g/plant) and chinese spinach (56.2 g/plant) perhaps reflecting a more efficient ability of lettuce roots to extract inherent soil nutrients. Root and other physiological studies are, however, needed to explain the 50–60% higher yield of lettuce compared to the other vegetables in the control plots.

Responses of yield (t/ha) to organic fertilizer

Regression analysis conducted to determine the optimum rate of organic fertilizer for all vegetables showed a quadratic effect on the yields (*Figures 1a–d*).

The yield response of leaf mustard can be represented by the equation $Y = -0.0144x^2 + 0.8279x + 8.0304$, where Y = yield in t/ha and x = rate of organic fertilizer applied (*Figure 1a*). The optimum rate of organic fertilizer was 28.75 t/ha and the yield obtained at this rate was 19.93 t/ha. This yield was much higher than the national average for the past 3 years, i.e., 14.43 t/ha (2008), 12.26 t/ha (2009) and 14.60 t/ha (2010) (DOA 2011). Heavy applications of poultry manure have been reported to be detrimental to crops due to the production of organic acids or phenolic compounds (Matzuzaki 1977; Shiga 1997).

For kangkung, the yield response is represented by the equation $Y = -0.0204x^2 + 1.1396x + 8.2818$ (*Figure 1b*) with optimum rate of organic fertilizer at 27.97 t/ha and yield obtained at 24.13 t/ha. Again this yield is very high compared to the national averages of only 8.78, 9.50 and 8.9 t/ha for the year 2008, 2009 and 2010 respectively (DOA 2011). Thus, organic fertilizer as the sole source of nutrients can indeed give very good yields.

The yield response of chinese spinach to increasing rates of organic fertilizer is represented by the equation $Y = -0.0174x^2 + 1.2521x + 9.0992$ (*Figure 1c*). The optimum rate of organic fertilizer applied was 35.98 t/ha with a yield of 29.63 t/ha which was much higher than the national average for 2008 (10.75 t/ha), 2009 (11.18 t/ha) and 2010 (11 t/ha) (DOA 2011).

For lettuce, the yield response is represented by the equation $Y = -0.0133x^2 + 0.7958x + 15.649$ (*Figure 1d*). The optimum rate of organic fertilizer was 29.92 t/ha and the yield obtained at this rate was 24.00 t/ha. The national average yield for lettuce was 11.24 t/ha for year 2008, 16.63 t/ha for year 2009 and 11.51 t/ha for 2010 (DOA 2011) which is much lower than the optimum yield obtained with organic fertilizer in this study.

Costs and returns from organic production

Organic production can give profitable returns due to the premium price that

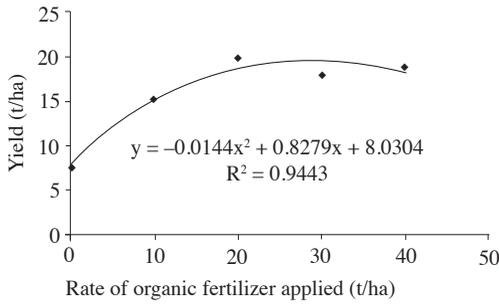


Figure 1a. Yield of leaf mustard vs rate of organic fertilizer applied

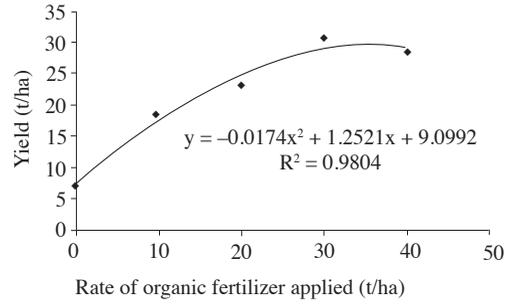


Figure 1c. Yield of chinese spinach vs rate of organic fertilizer applied

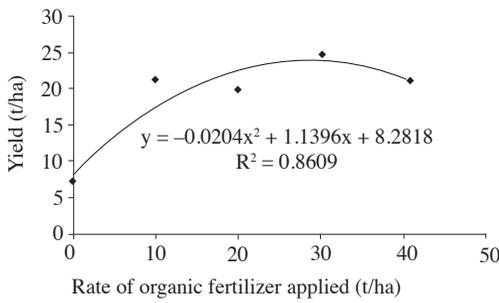


Figure 1b. Yield of kangkung vs rate of organic fertilizer applied

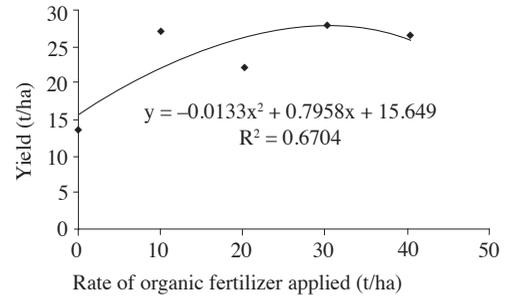


Figure 1d. Yield of lettuce vs rate of organic fertilizer applied

Table 9. Costs and returns for leaf mustard using organic vs conventional fertilizers

Fertilizer	*Experimental Yield (t/ha)	**Gross return	***Cost of fertilizer	Gross returns after deducting fertilizer cost
30 t/ha PM	13.5 t/ha	RM47,250	RM18,000	RM29,250
30 t/ha PM + 1 t/ha IF	19.8 t/ha	RM35,640	RM19,700	RM15,940

*Experiment yield calculated from the yield/plot in Table 7

**Farm-gate price of RM3500/t for organic and RM1800/t for non-organic leaf mustard

***RM600/t for PM and RM1700/t for IF

Source: FAMA Agricultural commodity price report: <http://sdvi.fama.net.my/>. Dated October 2011

organic produce commands. The returns from using organic fertilizer as the sole nutrient source vs organic + inorganic fertilizer is presented in Table 9 for leaf mustard, the most widely grown lowland leaf vegetable. The higher gross returns of RM29,250 from the organic leaf-mustard with a yield of 13.5 t/ha, compared to the return of only RM15,940 from using PM + IF with a higher yield of 19.8 t/ha, clearly illustrates the high returns possible from organic production. However, organic vegetable production is very labour intensive

compared to conventional production (Vimala 2005) and the higher labour costs incurred can reduce net profits. Nevertheless, higher net returns than conventional production can be obtained.

Conclusion

It is concluded that organic fertilizer as the sole source of nutrients can give yields that are higher or comparable to inorganic fertilizer. Thus, an organic grower need not fear reduced yields, if the correct rate of organic fertilizer is applied. The optimum

rate was about 30 t/ha of poultry manure for leaf mustard, kangkung and lettuce and 36 t/ha for chinese spinach.

Acknowledgement

The authors would like to thank Mr. Mohd Zain Mustapha and Mr. Mat Hassan Ismail for their assistance in conducting the trials at MARDI Station, Kubang Keranji, Kelantan.

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Abstrak

Empat jenis sayur berdaun iaitu sawi, kangkung, bayam dan salad ditanam di tanah lom lempung dengan penambahan kadar tahi ayam (0, 10, 20, 30 dan 40 t/ha), bersama baja kimia dan tanpa baja kimia, dengan 10 rawatan kajian. Kadar baja kimia ($N:P_2O_5:K_2O:MgO = 12:12:17:2$) yang diguna ialah 1 t/ha. Purata tinggi pokok sawi bertambah daripada 19.6 cm pada 24 hari selepas semaian (DAS) kepada 39.2 cm pada 32 DAS dengan purata bilangan daun masing-masing ialah 6.7 dan 9.7. Purata hasil pula ialah 5.5 kg/plot dan 337.7 g/pokok. Purata tinggi sayur kangkung ialah 33.1 cm pada 22 DAS dan 46.7 cm pada 29 DAS, manakala purata hasil pula 6.2 kg/plot dan 156.2 g/pokok. Purata tinggi sayur bayam pada 22 DAS dan 29 DAS masing-masing ialah 36.8 cm dan 66.7 cm, dan hasilnya ialah 7.2 kg/plot dan 188.2 g/pokok. Purata tinggi sayur salad ialah 20.8 cm pada 48 DAS dan juga 54 DAS. Bilangan daun salad ialah 11.0 pada 38 DAS, 31.2 pada 48 DAS dan 32.1 pada 54 DAS, manakala hasilnya ialah 6.6 kg/plot dan 164 g/pokok. Bagi kebanyakan sayur, penggunaan tahi ayam pada kadar 10 t/ha adalah kurang berhasil berbanding dengan hanya menggunakan baja kimia. Secara umumnya, penggunaan tahi ayam pada kadar 20 t/ha boleh memberi hasil yang setanding dengan hanya menggunakan baja kimia sahaja. Hasil optimum diperolehi daripada sawi, kangkung, bayam dan salad masing-masing ialah 19.9, 24.1, 29.6 and 24.0 t/ha. Hasil ini didapati dengan penggunaan baja organik yang optimum pada kadar 28.75 t/ha (sawi), 29.79 t/ha (kangkung), 35.98 t/ha (bayam) and 29.92 t/ha (salad).