Effect of poultry manure on the growth and yield of leaf mustard (*Brassica juncea*) and lettuce (*Latuca sativa*) grown on bris soil

A.H. Lim¹

¹Crop and Soil Science Research Centre, MARDI Headquarters, Persiaran MARDI-UPM, 43400 Serdang, Selangor, Malaysia

Abstract

Two leafy vegetables i.e. leaf mustard (*Brassica juncea*) and lettuce (*Latuca sativa*), were grown on a coastal sandy soil (bris) with increasing rates of poultry manure (PM), with and without inorganic fertiliser (IF). The rates of PM applied were 0, 10, 20, 30 and 40 t/ha and IF (N:P₂O₅:K₂O = 12:12:17:2) was applied at the rate of 1 t/ha, giving altogether 10 treatments. For both vegetables, 10 t/ha PM gave higher yields than IF alone. Yields obtained with PM as the sole source of nutrients ranged from 62 – 96% of the yields with PM + IF for leaf mustard and 88 – 113% for lettuce. Yield responses to increasing rates of organic fertiliser for leaf mustard showed a quadratic trend represented by the equation $Y = -0.0181x^2 + 1.0534x + 2.5537$. The optimum rate of poultry manure was 29.1 t/ha and the yield obtained was 17.9 t/ha. For lettuce, the yield response is represented by the equation $Y = -0.0067x^2 + 0.6239x + 6.6947$. The optimum rate of poultry manure was 46.6 t/ha and the yield obtained was 21.2 t/ha.

Keywords: sandy soil, organic fertiliser, poultry manure, inorganic fertiliser, leaf mustard, lettuce

Introduction

There are about 200,000 ha of sandy marine deposits found mainly along the east coast of Peninsular Malaysia, known locally as 'bris' soil. These sandy soils (>90% sand) are extremely infertile with negligible organic matter, and extremely low nutrient and water holding capacities. Bris soils have been ameliorated for vegetable production with the addition of both organic and inorganic fertilisers and good yields have been reported (Zahara and Vimala 1987; Vimala et al. 1990; Vimala and Zahara 1992; Zahara et al. 1992).

Organic sources and naturally occurring mineral nutrient sources are mandatory for organic cultivation. Organic sources as the sole source of nutrients have produced good yields on peat (Vimala, Mah, Roff, Ong et al. 2000; Vimala, Mah, Roff, Wan Rubiah et al. 2000; Vimala et al. 2001), on inland mineral soils (Vimala et al. 2006; Vimala et al. 2007; Lim and Vimala 2009) and in the highlands (Vimala et al. 2004). Organic sources also have been reported can enhance crop growth and improve yield by sustaining cropping system through slow releases of nutrient and better nutrient recycling (Ayuso et al. 1996; Ayoola and Adeniyan 2006; Eifediyi and Remison 2010). Besides this, Dada and Fayinminnu (2010) also reported that organic manures increase soil holding capacity that made nutrient more readily available to crops. With the current interest in organic vegetable cultivation and due to the fact that the better soils in the country have mostly been utilised for plantation crops, research

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 Author's full name: Lim Ah Hong

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 E-mail: ahlim@mardi.gov.my

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on organic cultivation on marginal soils like bris is timely. It is envisaged that vegetable farmers on bris soils can venture into organic cultivation if it is agronomically and economically feasible.

This study was conducted on two popular leafy vegetables in Malaysia i.e. leaf mustard (*Brassica juncea*) and lettuce (*Latuca sativa*) with two objectives: 1) to determine if organic sources as the sole source of nutrients can sustain leaf vegetable yields on bris soil, and 2) to establish optimum rates for organic cultivation on bris soil.

Material and methods

The experiment was conducted at MARDI Bachok, Kelantan on bris sandy soil (Rudua series). Some of the soil properties are presented in *Table 1*. Poultry manure (PM) at 0, 10, 20, 30 and 40 t/ha with and without inorganic fertiliser (IF) were evaluated on two leafy vegetables i.e. leaf mustard and lettuce on bris soil. Altogether 10 treatments including a control (without PM and IF) is laid as in *Table 2*.

The organic fertiliser, PM was applied as basal a week before transplanting and worked into the soil. The nutrient content of PM is presented in *Table 3*. Plot size was 2 m x 1 m and the planting distance was 20 cm x 20 cm to give 40 plants/plot.

Table 2. Fertiliser of treatments with different rates of poultry manure and inorganic fertiliser

Table 1. Soil chemical properties

	Values
Clay (%)	1.83
Coarse sand (%)	60.85
Fine sand (%)	35.82
Silt (%)	1.50
N (%)	0.13
Soluble P (ppm)	6.30
CEC $[cmol(+)kg^{-1}]$	1.01
Ex. Ca $[cmol(+)kg^{-1}]$	0.22
Ex. K $[cmol(+)kg^{-1}]$	0.16
Ex. Mg $[cmol(+)kg^{-1}]$	0.34

Treatment no.	PM (t/ha)	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 (Control)	0	0

Table 3	3. N	Jutrient	content	of	poultry	manure
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Nutrient	Content	Nutrients (kg) in the four organic rates applie			es applied
		10 t/ha	20 t/ha	30 t/ha	40 t/ha
Macronutrient (%)					
Ν	1.80	180	360	540	720
Р	2.86	286	572	858	1144
Κ	2.54	254	508	762	1016
Ca	13.30	1330	2660	3990	5320
Mg	1.09	109	218	327	436
Organic C	21.00	_	-	-	-
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
В	29	0.29	0.58	0.87	1.16

Leaf mustard was transplanted to the experimental plots at 14 days after sowing (DAS) and lettuce at 17 DAS.

For the PM + IF treatments, a compound fertiliser (N:P₂O₅:K₂O:MgO = 12:12:17:2 + Te) was applied at 1 t/ha, in two split applications at 1 week (1st top) and 3 weeks (2nd top) after transplanting. The chemical fertilisers were applied in furrows in between the planting rows and covered with sand. The nutrient elements in the compound fertiliser applied are presented in *Table 4*.

For the organic only treatments, no IF was applied. A control treatment, without organic and IF was included. The experiment was arranged in a randomised complete block design with three replicates.

Leaf mustard was harvested at 37 DAS and lettuce at 54 DAS. Routine agronomic practices were followed for crop management and pest control. *Plate 1* shows leaf mustard and lettuce on bris soil just before harvest.

Plant height and leaf number of leaf mustard were measured at intervals of 24, 31 and 37 DAS. For lettuce, plant

Nutrient	Content (%)	Nutrients (kg) in one ton compound
		fertiliser
N	12.00	120.0
Р	5.28	52.8
Κ	14.10	141.0
Mg	1.20	12.0

height, leaf number and canopy width were measured at 38, 48 and 54 DAS. Fresh yield at harvest was recorded for both 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 compared by the Duncan multiple range test (DMRT) method using the statistical package of SAS Institute. Regression analysis was used to obtain the optimum rate of organic fertiliser.

Results and discussion *Plant height*

Leaf mustard Plant height at 24 DAS ranged from 8.9 – 15.6 cm. At 31 DAS, the height did not differ significantly except for the control which was significantly lower than the other treatments while 10 t/ha PM + IF was significantly higher than the other treatments. At 37 DAS, the height did not differ significantly except for the control (*Table 5*).

Lettuce The height ranged from 12.1 - 19.3 cm at 38 DAS and did not differ significantly except for the control and only IF treatments, both of which gave significantly shorter plants than the other treatments. At 48 DAS, IF and the control too gave significantly shorter plants than the other treatments. At 54 DAS, again, the control and IF gave significantly shorter plants than the other treatments (*Table 5*).



Plate 1. Leaf mustard (left) and lettuce (right) on bris soil at MARDI Bachok, Kelantan

PM	IF	Leaf mustard			Lettuce		
		24	31	37	38	48	54
0	0	8.9c	11.1c	15.1b	12.1b	17.8b	17.9b
0	1	12.8b	21.0b	33.2a	12.8b	16.7b	20.0b
10	0	15.6a	24.0b	36.7a	17.9a	27.0a	32.1a
10	1	14.3ab	29.2a	41.9a	19.5a	30.3a	34.9a
20	0	14.3ab	23.0b	38.0a	16.6a	27.0a	33.7a
20	1	12.4b	21.7b	40.4a	19.3a	28.4a	35.9a
30	0	13.8ab	21.1b	35.5a	18.5a	26.4a	34.0a
30	1	14.1ab	22.7b	38.9a	18.1a	29.3a	35.0a
40	0	14.0ab	22.4b	37.5a	18.5a	27.0a	34.3a
40	1	13.9ab	23.0b	36.8a	18.6a	28.0a	34.9a
Mean	l	13.4	21.9	35.4	17.1	25.8	31.3
Signi	ficance	**	**	**	**	**	**
CV%		10.9	16.3	15.8	12.0	10.7	10.5

Table 5. Plant height (cm) at various rates of poultry manure and inorganic fertiliser after days of sowing

**Significant at *p* <0.01

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

This shows that with the addition of IF there is no significant increase in plant height. This result corresponded with the reports presented earlier by Ayuso et al. (1996) and Eifediyi and Remison (2010) that organic sources alone can sustain crop growth and development.

Leaf number

Leaf mustard The leaf number at 24 DAS ranged from 4.8 - 6.0. Though there were some significant differences between the treatments, no clear trend could be discerned. At 31 DAS, the leaf number did not differ significantly except for the control. At 37 DAS, the leaf number ranged from 6.0 - 10.0, and as for 31 DAS, there is no significant difference except for the control (*Table 6*).

Lettuce The leaf number at 38 DAS ranged from 8.3 - 14.0 cm. At 48 DAS, the leaf number ranged from 12.0 - 20.8 cm. At 54 DAS, the leaf number ranged from 14.8 - 31.0 cm. Though significant differences were obtained, no clear trend could be discerned, except for the control and IF, both of which gave significantly lower leaf numbers compared to the other treatments (*Table 6*).

Canopy width

Lettuce The mean canopy width ranged from 19.2 - 30.8 cm at 38 DAS, 20.9 - 37.5 cm at 48 DAS and 23.1 - 36.0at 54 DAS (*Table 7*). Generally, there were little significant differences between the treatments, except for the control and IF, both of which were significantly lower than the other treatments. Ojeniyi (2000) also reported that differences in treatment do not necessarily give a significant variation on leaf area of any crop.

Plot yield

Leaf mustard Higher yields were obtained with PM + IF compared to only PM at all rates (*Figure 1* and *Table 8*). Poultry manure as the sole nutrient source at all rates gave higher yields (4.0 - 5.3 kg/plot) compared to IF alone (3.0 kg/plot), indicating that organic fertiliser as the sole source of nutrients need not necessarily give reduced yields, as generally perceived. Though high levels of

PM	IF	Leaf mu	Leaf mustard		Lettuce		
		24	31	37	38	48	54
0	0	4.8b	5.3b	6.0b	8.2d	12.0c	14.8c
0	1	4.8b	7.3a	9.3a	9.3cd	13.0bc	18.0c
10	0	5.5ab	7.3a	10.0a	12.0ab	18.8a	24.0b
10	1	5.3ab	7.5a	9.3a	12.8ab	19.8a	27.0ab
20	0	5.5ab	7.3a	9.8a	14.0a	20.8a	31.0a
20	1	5.3ab	7.5a	9.5a	13.3ab	16.8ab	25.8b
30	0	5.5ab	7.8a	9.0a	13.0ab	20.5a	26.8ab
30	1	6.0a	7.3a	10.0a	11.3bc	18.3a	24.5b
40	0	5.8ab	7.5a	8.5a	13.3ab	20.5a	25.5b
40	1	5.8ab	8.0a	9.5a	13.0ab	19.8a	24.8b
Mea	n	5.4	7.3	9.1	12.0	18.0	24.2
Sign	ificance	*	**	**	**	**	**
CV%	6	12.4	10.1	13.1	12.2	15.4	12.9

Table 6. Leaf number at various rates of poultry manure and inorganic fertiliser after days of sowing

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

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

Table 7. Canopy width (cm) of lettuce at various rates of poultry manure and inorganic fertiliser after days of sowing

Treatm	ents (t/ha)	Days after sowing (DAS)			
PM	IF	38	48	54	
0	0	19.4b	21.4c	25.3b	
0	1	19.2b	20.9c	23.1b	
10	0	28.4a	31.9b	33.4a	
10	1	31.8a	33.0ab	35.1a	
20	0	28.9a	33.9ab	35.3a	
20	1	30.8a	34.8ab	35.4a	
30	0	29.3a	34.6ab	33.6a	
30	1	30.4a	34.0ab	35.1a	
40	0	27.6a	35.1ab	36.0a	
40	1	29.4a	37.5a	35.0a	
Mean		27.5	31.7	32.7	
Significance		**	**	**	
CV%		12.4	10.0	7.2	

**Significant at *p* <0.01

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

nutrients are present in 10 t/ha PM (Table 2), 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 values, 10 t/ha would only provide 54 kg N, 57 kg P and 76 kg P which clearly are lower compared to the nutrients found in 1 t/ha IF and the higher rates of PM (Tables 3 and 4). The higher yields obtained with 10 t/ha PM (4.0 kg/plot) compared to IF (3.0 kg/plot) are attributed to the slow release of nutrients (Ayuso et al. 1996; Eifediyi and Remison 2010) and less leaching losses from PM compared to IF which is easily prone to leaching losses due to the sandy texture of bris soil. Previous studies on leaf mustard on clay loam soil gave higher yields with 1 t/ha IF (5.1 kg/plot) compared to 10 t/ha PM (4.5 kg/plot) (Lim and Vimala 2009). The very low yield (0.4 kg) from the control treatment proves the extremely low fertility status of bris soil.



Figure 1. Yield of leaf mustard lettuce with poutry manure (PM) and PM + inorganic fertilizer (IF)

Lettuce As obtained with leaf mustard, lettuce gave better yields with PM at all rates compared to IF only (*Figure 1* and *Table 8*). For example, PM at 10 t/ha as the sole source of nutrients gave higher yields (4.2 kg) than IF alone (1.9 kg). Studies elsewhere (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 fertilisers.

Table 8. Yield/plant at various rates of poultry
manure and inorganic fertiliser after days
of sowing

Ttreatments (t/ha)		Yield (g/plant)		
РМ	IF	Leaf mustard	Lettuce	
0	0	10.4d	42.9e	
0	1	74.4c	46.3e	
10	0	99.1bc (61.5)	105.7d (93.9)	
10	1	161.0a	112.5cd	
20	0	132.2ab (85.1)	127.2bcd (87.9)	
20	1	155.3a	144.7ab	
30	0	106.9bc (63.5)	127.2bcd (94.7)	
30	1	168.3a	134.4bc	
40	0	129.7ab (91.0)	165.7a (112.5)	
40	1	135.0ab	147.2ab	
Mean		117.2	115.4	
Significance		**	**	
CV%		23.9	14.3	

**Significant at p <0.01

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

(Figures in brackets refer to the % yield obtained with PM as the sole source of nutrients compared to PM + IF)

Yield per plant

Leaf mustard Significant differences in yield/plant were obtained between treatments (*Table 8*). The yield/plant ranged from 10.4 (control) – 168.3 g (30 t/ha PM + IF). Yields obtained with PM as the sole source of nutrients ranged from 62 – 96% of the yields with PM + IF.

Lettuce Yield/plant ranged from 42.9 (control) – 165.7 g/plant (40 t/ha PM). The control plot gave four folds higher mean yields (42.9 g/plant) of lettuce compared to the control plot of leaf mustard (10.4 g/plant), perhaps due to a more efficient photosynthetic ability and a more efficient ability of lettuce roots to extract inherent soil nutrients. Similar observation was obtained in another study (Lim and Vimala 2009). Yields obtained with PM as the sole source of nutrients ranged from 87.9 - 112.5% of the yields obtained with PM + IF.

Yield per hectare

Leaf mustard The yield response of leaf mustard can be represented by the equation $Y = -0.0181x^2 + 1.0534x + 2.5537$ where, Y = yield in t/ha, and x = rate of organic fertiliser applied (Figure 2). The optimum rate of organic fertiliser was 29.1 t/ha. The yield obtained at this rate was 17.9 t/ha, which was much higher than the national average with ranged from 12.0 - 15.1 t/ha as reported by DOA (2012), for the past few years. Assuming the cost of organic fertiliser to be RM800/t, the optimum rate of organic fertiliser would cost the grower RM23,280 (29.1 t/ha x RM800/t). At a conservative premium price of RM4,000/t, the gross income for organic leaf mustard would be RM71,600 (17.9 t/ha x RM4,000). This will translate to a gross return of RM48,720 (RM71,600 - RM23,280). Comparing this to a gross return of RM33,400 (assuming the price of conventionally grown leaf mustard to be RM2,000/t and the price of IF to be RM2,400/t and the yield to be 17.9 t/ha), the organic cultivation on bris soil can indeed be profitable even if organic cultivation entails higher labour costs.

Lettuce For lettuce, the yield response is represented by the equation $Y = -0.0067x^2 + 0.6239x + 6.6947$ (*Figure 2*) with optimum rate of poultry manure at 46.56 t/ha and yield obtained was 21.22 t/ha. The yield obtained is higher compared to the national averages that ranged from 11.2 – 17.2 t/ha for the past 5 years (DOA 2012). Thus, organic fertiliser as the sole source of nutrients can indeed give very good yields.

Conclusion

It is concluded that organic fertilisers as the sole source of nutrients can give good yields on bris soils. Thus, a grower of organic produce need not fear of reduced yields, if correct rate of organic fertilisers were applied. For leaf mustard and lettuce grown on bris soils, the optimum rate of poultry manure are 29.1 and 45.56 t/ha respectively.



Figure 2. Yield of leaf mustard and lettuce vs rate of poultry manure (PM)

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Abstrak

Baja tahi ayam (PM) telah diuji pada kadar 0, 10, 20, 30 dan 40 t/ha dengan dan tanpa baja kimia (IF) terhadap pertumbuhan dan hasil sawi dan salad yang ditanam di tanah bris. Kadar baja IF (N:P₂O₅:K₂O = 12:12:17:2) yang digunakan ialah 1 t/ha. Sebanyak 10 perlakuan kajian telah dijalankan. Bagi kedua-dua jenis sayur, baja organik pada kadar 10 t/ha memberi hasil yang lebih tinggi daripada baja kimia. Hasil yang didapati dengan kegunaan PM sahaja sebagai sumber nutrien adalah 62 – 96% hasil yang didapati daripada kegunan PM + IF untuk sayur sawi dan 88 – 113% untuk sayur salad. Perhubungan antara hasil dengan kadar baja organik untuk sawi adalah quadratik, Y= $-0.0181x^2 + 1.0534x + 2.5537$. Kadar baja organik yang optimum 29.1 t/ha. Hasil sawi pada kadar ini adalah 17.9 t/ha. Untuk salad, perhubungan antara hasil dengan kadar baja organik ialah Y = $-0.0181x^2 + 1.0534x + 2.5537$. Kadar optimum bagi baja organik ialah 46.6 t/ha dan hasil salad ini ialah 21.2 t/ha.