The Effect of Organic Materials and Decomposer on Soybean Growth and Production

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Abstract

Field experiment was set up in Cikarawang, Darmaga Bogor, Indonesia from December 2010 to April 2011. The objective of the study was to investigate the effect of chicken manure, rice straw, and green manure of *Tithonia diversifolia* with the application of decomposer, i.e. chicken manure liquid, chicken manure + *Tithonia diversifolia* liquids, and biofertilizer under organic farming system. A randomized block design was laid out with organic materials (chicken manure, rice straw and green manure of *Tithonia diversifolia*) as the first factor and decomposers (chicken manure liquid, chicken manure + *Tithonia diversifolia* liquid, and biofertilizer) as the second factor. The results showed that chicken manure gave the best effect on soybean growth and production. Soybean productivities from organic treatment chicken manure, green manure of *Tithonia diversifolia,* and rice straw were 1.00, 0.85, and 0.73 ton dry seed ha^{-1}, respectively. Biofertilizer gave better response on soybean growth and production components than chicken manure + *Tithonia diversifolia* liquid, chicken manure liquid and control, i.e. 089, 088, 0.82, and 0.98 ton dry seed ha^{-1}, respectively.

*Keywords: organic soybean, decomposer***,** *chicken manure, rice straw,* Tithonia diversifolia *Hemsl*

Introduction

Increasing the inputs of nutrients has played a major role in increasing the supply of food to a continually growing world population. However, focusing attention on the most important nutrients, such as nitrogen (N), has in some cases led to nutrient imbalances, some excess applications especially of N, inefficient use and large losses to the environment with impacts on air and water quality, biodiversity and human health. In contrast, food exports from the developing to the developed world are depleting soils of nutrients in some countries. Better management of all essential nutrients is required that delivers sustainable agriculture and maintains the necessary increases in food production while minimizing waste, economic loss and environmental impacts. More extensive production systems typified by 'organic farming' may prove to be sustainable. However, for most of the developed world, and in the developing world where an ever-growing population demands more food, it will be essential to increase the efficiency of nutrient use in conventional systems (Gouldin *et al*., 2008).

The success of organic system in supporting national food security is still in doubt because the production of organic farming system is generally less than that of conventional farming. However, organic farming system may be able to support food security in local level because the continuity of plant production is possible. Farmers can use on-farm inputs that normally are available at production site and avoid the use of chemical fertilizer and pesticide which is relatively expensive and negative impact to the environment.

Animal and green manure can be used as organic fertilizer for production of organic vegetable soybean (Melati and Andriyani, 2005; Sinaga, 2005; Kurniasih, 2006). Chicken manure gave better result than sheep manure (Sinaga, 2005), while *Centrosema pubescens* was better than *Calopogonium mucunoides* and *Crotalaria juncea* (Sinaga, 2005; Kurniasih, 2006). Chicken manure 10 ton ha^{-1} increased the vegetative growth and production in organic soybean (Melati and Andriyani, 2005).

In Indonesia, soybean is one of the crops used in the cropping pattern in the lowland. Arafah and Sirappa (2003) stated that rice straw should be incorporated to the soil after every harvest so it can be beneficial to the next crop in the cropping pattern. Indriani (2000) found that *Tithonia diversifolia* contains high nutrients, especially Nitrogen. This nitrogen can be useful in assisting decomposting bacteria in decomposition process.

One of the obstacles in organic agriculture is the decomposition process of the organic matter in the soil. Local microorganisms from various organic matters (fruits, plants, fish bones, dead animal and garbage) around us can be used as media for microorganism for decomposition process (Indriani, 2000). This effort can be used to optimize the growth and activity of the microorganism that decomposed the organic matter (Sutaryono dan Fauzi, 2007). Combination of biofertilizer and various organic matters influenced the physical and biological soil properties (Mezuan *et al.,* 2002). Bertham (2002) studied biofertilizer application that showed the increasing total pod number, filled pod number, and root nodule number in soybean. Further Hindratno (2006) found that decomposer application or chicken manure liquid as decomposer increased the plant height and fresh pod of vegetable soybean weight than without decomposer application.

This research was aimed to study the influence of organic matter, i.e. chicken manure, rice straw, and *Tithonia diversifolia* with decomposer, i.e. chicken manure liquid, chicken manure+*Tithonia diversifolia*, and biofertilizer (Bioextrim) to the organic soybean production.

Materials and Methods

The research was carried out at organic research station Cikarawang, Bogor, West Java, Indonesia, from November 2010 to April 2011. A randomized block design was laid out with organic materials (i.e. chicken manure, rice straw, and green manure of *Tithonia diversifolia*) as the first factor and decomposers (i.e. chicken manure liquid, chicken manure + *Tithonia diversifolia* liquid, and biofertilizer Bioextrim) as the second factor. Duncan's Multiple Range Test (DMRT) with α=5% and t-Dunnet test for comparison between treatments with control (rice straw without dekomposer) were used in this experiment.

Liming with 2 tonnes dolomit ha^{-1} and 2 ton ash ricehull ha^{-1} were given in row for soil conditioning 4 Weeks Before Planting (-4 WAP/Weeks After Planting). Organic matter as treatments were given in the form of 10 tonnes chicken manure ha^{-1}, 10 ton rice straw ha^{-1}, and 10 tonnes of *Tithonia diversifolia* ha^{-1} and decomposer in the form of chicken manure liquid, chicken manure + *Tithonia diversifolia* liquid, and biofertilizer. Coconut water and red sugar, i.e. 40 l and 4 kg, were used as the solution for each type of decomposer liquid and then fermented for 6 weeks (at -6 WAP) and given as soil drench.

Cymbopogon nardus and *Tagetes erecta* L. were used as the repellent plant (Kusheryani and Aziz, 2005). Extract of *Cymbopogon nardus*, *Cymbopogon nardus* + *Tithonia diversifolia*, and neem (*Azadirachta indica* A. Juss) were used as organic pest control and sprayed every week. Soybean of Wilis variety were planted 25 x 10 cm with the repellent plant in the middle of every plot.

Results and Discussion

The soil analysis before the experiment showed pH at 5.7 (slightly acid), C-organic at 1.20% (high), total N at 2.2 ppm (low), CEC low, base saturity of 29.26% (medium). Clay in texture (sand, loam and sand, i.e. 6.93, 23.26 and 69.81%, respectively). After the treatment the pH on control, *Tithonia diversifolia* and biofertilizer were 5.7 (slightly acid). On rice straw and chicken manure liquid, and rice straw and biofertilizer the pH increased to 6.50, whereas the other six treatments were neutral to base (6.60-7.30). Low total nitrogen (0.12-0.22%), high C-organic was 1.20-2.39%, P availability was 2.80-10.20 ppm, low to high K at 0.29-0.94 me/100g, high base saturity was 64.04-96.15%.

Penta and tetra-foliate leaves found on 7 WAP, mostly on *Tithonia diversifolia* plots, with dark green colour, broad leaves and thicker canopy. On 5 WAP *Pseudomonas syringae* pv. glycinea were found on every plant. Saleh and Hardaningsih (2007) stated that this disease was mostly found in high altitude in Indonesia, with wet weather and high temperature.

Organic matter significantly affected seed growth percentage at 2 WAP, number of branches on 3, 5, 7, 9, 11, 13 WAP; number of tetra and penta-foliate on 7 WAP; shoot, root, nodule wet and dry weight on 7 WAP, disease prevalence on 8 WAP; insect infestation on 8 and 10 WAP; number of empty pod on 13 WAP; number of plant harvested; dry seed weight per 7.5 m^2; and soybean productivity (Table 1).

Table1. Organic matter on vegetative and generative variables

Variables	WAP	Organic Matter						Control
		Chicken Manure		Rice Straw		*Tithonia diversifolia*		
Growth percentage	2	336.33	b	369.22	ab	386.11	a	382.33
Plant height (cm)	13	12.79		12.88		13.53		12.59
Number of branches	11	51.06		52.22		49.76		49.85
Number of productive branches	13	3.17	a+	2.90	b+	2.83	b+	2.47
Leaf number	3	8.73	a+	6.69	bc	7.26	b	6.37
	11	10.54	a+	9.24	ab	8.43	b	8.63
Tetrafoliate	7	10.33	a+	9.12	ab	8.30	b	8.53
Pentafoliate	7	10.24	a+	9.06	ab	8.13	b	8.40
NAR (g/cm^2/weeks)	5-7	9.79	a	8.82	ab	7.94	b	8.27
	7-9	2.77		2.75		2.78	+	2.60
RGR (g/weeks)	5-7	6.59		5.92		6.07		6.00
	7-9	12.38		11.49		11.51		11.63
Nodule wet weight (g)	7	135.11	a+	77.33	c+	87.78	b+	68.00
Shoot dry weight (g)	7	37.11	a+	17.78	c+	24.56	b+	8.67
Leaf water content (%)	7	0.34		0.15		0.28		0.05
Insect infestation (%)	10	5.07	b	3.73	b	7.53	a+	4.70
Disease prevalence (%)	8	0.74	b+	0.51	c	1.03	a+	0.52
Number of filled pod		24.14		19.10		21.43		19.50
Number of empty pod		3.16	a+	1.74	ab	2.72	a	1.07
Seed dry weight (g)		46.69		33.28		40.36		36.58
Number of plants harvested		217.11	b	241.00	ab	249.89	a	255.33
100 seed dry weight (g)		9.59		9.15		8.98		8.65
Seed dry weight /7.5 m^2 (g)		752.44	a	550.67	b	636.78	ab	738.33
Productivity (ton/ha)		1.00	a	0.73	b	0.85	ab	0.98

Numbers followed by different letters in the same row significantly different at 5 and 1 % DMRT test; figures followed by (+) in the same row significantly different at 5% Dunnet test with the control.

Decomposer significantly affected number of branches on 3, 5 WAP; number of tetra and penta foliate on 7 WAP; Nett Assimilation Rate (NAR) on 7-9 WAP; shoot and root wet weight on 7 WAP; shoot dry weight on 7 WAP; disease prevalence on 8 WAP; and insect infestation on 8 WAP (Table 2). Combination of organic matter and decomposer significantly affected Nett Assimilation Rate on 7-9 WAP; shoot and root wet weight on 7 WAP; shoot and root dry weight on 7 WAP; and insect infestation on 10 WAP.

Table2. Decomposer on vegetative and generative variables

Variables	WAP	Decomposer						Control
		Chicken Manure Liquid		Chicken manure + *Tithonia diversifolia* liquid		Biofertilizer		
Growth percentage	2	357.67		372.33		361.67		382.33
Plant height (cm)	13	50.83		51.29		50.93		49.85
Number of branches	3	3.04	a+	3.01	a+	2.85	b+	2.47
	5	7.8	+	7.6	+	7.3		6.4
	11	9.3		9.5		8.6		8.4
Number of productive branches	13	8.9		9.2		8.5		8.3
Leaf number	3	2.8		2.8	+	2.7		2.6
	11	11.3		10.7		9.6		10.1
Tetrafoliate	7	102.1	a+	100.1	ab+	98	b+	68
Pentafoliate	7	27.7	a+	26.3	ab+	25.1	b+	8.7
NAR (g/cm^2/weeks)	5-7	$2.5x10^{-3}$		$1.9x10^{-3}$		$2.4x10^{-3}$		$4.5x10^{-4}$
	7-9	$2.8x10^{-3}$	a	$1x10^{-3}$	b	$7.6x10^{-4}$	b	$1x10^{-3}$
RGR (g/weeks)	5-7	0.26		0.23		0.29		0.05
	7-9	0.18		0.1		0.07		0.12
Shoot wet weight (g)	7	4.6	b	5.16	b	6.63	a+	4.7
Root wet weight (g)	7	0.65	bc	0.7	b	0.93	a	0.52
Shoot dry weight (g)	7	1.34	b	1.36	b	1.94	a	1.41
Nodule dry weight (g)	7	0.03		0.03		0.04	+	$9x10^{-3}$
Insect infestation (%)	8	20.89	a+	19.47	b+	21.98	a+	29.16
	10	6.89		7.69		7.67		5.48
Disease prevalence (%)	8	69.16	ab+	68.29	b+	69.65	a+	79.46
Seed dry weight (g)		41.49		40.3		38.54		36.58
Number of plants harvested		231.8		239.6		236.7		255.3
100 seed dry weight (g)		9.18		9.39		9.15		8.65
Seed dry weight /7.5 m^2 (g)		658		615.67		666.22		738.33
Productivity (ton/ha)		0.88		0.82		0.89		0.98

Numbers followed by different letters in the same row significantly different at 5 and 1 % DMRT test; figures followed by (+) in the same row significantly different at 5% Dunnet test with the control

The higher result on control plots seemed to be affected by the plot placement in the field that supplied more water in the beginning of the experiment than the treatment plots. Soil in the treatment plots were hard because of the changed condition from paddy field to the rain-fed condition for the soybean planting. All the organic manure was recommended for soybean planting after paddy field. There was no need to apply decomposer after the paddy field for soybean planting with rice straw incorporation to the soil.

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