International Journal of Agricultural Science and Technology (IJAST) Volume 2 Issue 2, May 2014 www.seipub.org/ijast
doi: 10.14355/ijast.2014.0302.04

Developing an Organic Farming System in Maluku

Aurellia Tatipata *[1], Agustinus Jacob[2]

[1] Department of Agrotechnology, University of Pattimura, Jalan Ir. M. Putuhena Kampus Poka Ambon 97121

[2] Department of Agrotechnology, University of Pattimura, Jalan Ir. M. Putuhena Kampus Poka Ambon 97121

* lethatatipata @yahoo.com

Received 18 Nov, 2013; Accepted 10 Feb, 2014; Published 10 May, 2014

Abstract

Organic farming is a system used to increase long-term soil fertility in Maluku. The aim of our experiment was to develop continuous agricultural production to improve the sustainability of food supply in Maluku. The experiment was important in attempting to provide long-term benefits to the environment, making use of local bio resources, namely sago waste and city organic waste as compost, in order to improve and cultivate local plants and nutritious food. The experiment conducted in Waisamu and Passo, consisted of two treatments, i.e. making compost from sago waste and city organic waste, and then applied to local corn. Each treatment consists of two factors and three replications, using Randomized Complete Block Design; the first of which is types of compost, i.e. from sago waste and city organic waste; while the second factor is compost dosage, onsisting of five levels, i.e. 0 ton per hectare, 7, 5 ton per hectare, 10 ton per hectare, 12, 5 ton per hectare, 15 ton per hectare. The variables observed for compost quality are C/N ratio, mineral content N, P, K, Ca, Mg, Fe. Height and leaf area of plant, weigh, diameter and amount of stem on an ear were observed for growth and production of plant. The results proved that the higher dosage the 15 ton per hectare of the compost is, the higher of growth and production of the corn, 250 g compost from organic city waste is which improves the higher growth and production of pakchoy (*Brassica chinensis*). Composts from sago waste and city organic waste contain macro and micro nutrient that increases the nutrient content of soil, improving plant growth and corn production.

Keywords

Compost; Sago Waste; City Organic Waste

Introduction

Organic farming system is a method of farming system to provide the consumer with fresh, tasty and authentic food while respecting natural life-cycle systems and to increase long-term soil fertility.To achieve this, organic farming relies on a number of objectives and principles, as well as common practices designed to minimize the human impact on the environment, while ensuring the agricultural system operates as naturally as possible.

Maluku is islands province, consisting of small islands and 90% sea area. Small islands according to the 'land area' category is a relative concept, specially, the size is less than 10.000 km^2 (BPSMaluku, 2008). Depending on many small islands, greater amount of fertilizer and pesticides are needed to produce the same yields of crop, which is challenging. On the other hand, fertilizer and pesticides inorganic are expensive to poor farmer, and artificial chemicals destroy soil micro-organisms resulting in poor soil structure and aeration as well as decreasing nutrient availability, Pests and diseases become more difficult to control as they become resistant to artificial pesticides. Maluku has a greater amount of bio resources such as sago palm and many crops for example nutmeg, clove, *Aegle Marrmelos*, betel, soursop, etc that used to make pesticides. It has been estimated that about two tones of sago starch, extracted from sago palms are produced per day at villages in Maluku and about 4 to 5 tons of sago waste are produced. Most of the factories are built near river sides as sago waste is likely to be discarded into rivers, a practice which may cause water pollution. On the other hand, it ihas been estimated that about 2 tones of city organic waste are produced a day. Sago waste and city organic waste can be used for composting on soil and water conservation, and management practices that restore, maintain and enhance ratio low under 20%.

Organic fertilizers are better for plants and healthier for human than chemical fertilizer, due to no harmful chemicals, and they boost the growth of beneficial soil organisms and promote healthier root development., provide better balanced nutrition in forms more readily available to plants and add organic material, keeping soil friable, helping it hold moisture, oxygen and nutrients. Fertilizers made from plants generally have low to moderate N-P-K (nitrogen, phosphorus, potassium) values, but their nutrients quickly become available in the soil for plants to use. Some of them even provide an extra dose of trace minerals and micro nutrients. Residual effects of manure or compost application can maintain crop yield level for several years after manure or compost application ceases since only a fraction of the N and other nutrients in manure or compost become plant available in the first year after application (Motavalli *et al*., 1989; Eghball *et al*., 2002). Residual effects of N- or P-based manure or compost application increased corn production for one year and influenced soil properties for several years (Bahman Eghball, Ginting, and John E. Gilley, 2004).

The aim of our experiment was to develop continuous agricultural production to improve the sustainability of food supply in Maluku. The benefit of our experiment were to renewable soil and water conservation, management practices that restore, maintain and enhance ecological balance and allow people to consume nutritious food.

Experimental

Materials

Materials that used in the research were sago waste, grass, kitchen scraps, leaves, dolomite lime, molasses, effective microorganism-4, cow manure. Local seed corn, i.e. pulut corn and delima corn were collected from Kisar, one villages in Maluku South West. The research was conducted in Waisamu, West of Seram regency and Passo, centre of Maluku regency since May until October 2012.

Composting Methods

Sago waste chopped with machine and put it on the

Floor. Begin the pile with 2" layer of sago waste and add a 1" layer of cow manure, dolomite lime (500 g) and pour with an effective microorganism 4 which mixed with molasses as bioactivator. Repeat the layers until the pile is about 4 high. Add just enough water to moisten the pile, then cover it with a black plastic. Turn the pile every the fourth day until the compost is finished. Using the same methods to composting city organic waste (leaves, fresh grass clipping, kitchen scraps, etc). The compost should be finished in about four weeks. Finished compost is dark brown, crumbly, and has an earthy odor.

Field Preparation and Planting

The field was tilled twice at a depth of 25 cm. Once each plot received the assigned amount of compost, the field was tilled to incorporate the compost into the top 15 cm of the soil. Seed local corn was planted in 5 cm deep. Plant distance of seed corn was 70 x 50 cm. *Brassica chinensis* seed was planted in polybag

Plot Layout and Experimental Design

Each corn seed was planted in a 336 m^2 plot (15 x 21 m^2). Each plot was divided into 3 blocks, each was 20 m^2 (5 x 4 m). The research using a randomized block design with one factor. There are two treatments: The compost of sago waste applied on corn plant in Waisamu consisting of five levels: 0 t ha^{-1}; 7,5 t ha^{-1}; 10 t ha^{-1}; 12,5 t ha^{-1}; 15 t ha^{-1}. The compost of city organic waste applied on *Brassica chinens*is at integrated waste city installation in Passo. Pakchoy were planted in polybag. There are five levels compost per polybag, i.e. 0g; 150g, 200g, 250g and 300g. Each of the two treatments replicated three times. This meant that each of the two treatments consisted of 15 plots. Each of two treatment consisted of 525 seeds corn (141 corn crop/ plot and 141 polybag to planting pakchoy).

Data collection and analyses

Soil

Samples of soil were taken from each plot before planting for analysis of macro and micro nutrient, pH, cation change capacity at Soil Research Centre.

Compost

Samples of all types of compost were analyzed before application in order to quantify the amounts of macro and micro nutrient, cation cxhange capacity, moisture content, pH..

Sampling

Samples were taken from the plants at growth stages and at harvest. Five corn plants per plot were randomly selected for sampling, while each pakchoy per polybag.

Maintenance

Local corn and pakchoy were sprayed with organic pesticides for insect/pest and disease control. Crop watered two times a day.

Variables

Variables of corn that measured at optimum growth stages were plant height, leaf number, leaf area. The plant height, leaf number of the pakchoy was measured every week. At harvest, the corn ears and were collected and weighed. Variables of corn that measure after harvest were length, diameter and weight of corn ears, dry weight shelled grain. Leaf area was measured using formula by Pearce *et al* (1988)

LD (cm²) = (p x ℓ x K)

LD = leaf area (cm2)

p = length of leaf sample (cm)

ℓ = width of leaf sample(cm)

K = correction factor

$$K = \frac{\frac{C}{B} \times A}{p \times l}$$

A = paper area to draw leaf sample (cm²)

B = paper weight (g)

C = weight of each replica (g)

P = leaf length

ℓ = leaf width

Statistical analyses

The analysis of variance (ANOVA) procedure of the SAS system software, Version 9.2, (SAS Institute Inc., Cory, NJ, USA) was used to evaluate effect of treatments. Means values of the plant height, leaf number, leaf area, ear length, ear diameter, ear weighy, weight of dry shelled grain with different levels of compost were compared using Duncan's test.

Results and Discussion

Variable of Compost

The compost variables from sago waste and city organic waste are reported in Table 1.

Compost from city organic waste had a lower N, P, K, C-organic, Cu , Mg content compared to that from sago waste, but other content were higher in compost from city organic waste. This meant that nutrient content of compost depending on compost material. Dependency on value soil chemistry criteria of Soil Research Centre Bogor (1983) *cit* Sarwono (2007), C-organic, N-total, P_2O_5, K_2O and pH of research area soil in Passo were 2,57%, (low), 0,25% (low), 19 mg/kg (moderate), 0,14 cmol(+)/kg (moderate), 5,7 (acid), respectively (Tatipata and Jacob, 2012 a), while C-organic, N-total, P_2O_5,, K_2O of soil in Waisamu were 1,63% (low), 0,15% (low), 19 mg/kg (moderate), 0,42 cmol(+)/kg (moderate), respectively (Tatipata and Jacob, 2012b). Compost from sago waste and city organic waste that applied on soil can adds nutrients and organic matter, so these provide nutrients for growth corn and pakchoy.

TABLE 1 THE VARIABLE OF THE COMPOST FROM SAGO WASTE AND CITY ORGANIC WASTE

Variable	Sago waste compost	Organic city waste compost
N -total (%)	1,14	1,08
P (%)	1,11	0,50
K (%)	4,32	0,29
Ca (%)	0,85	6,54
Mg (%)	2,58	0,65
Co (ppm)	95,46	-
Zn (%)	0,03	140 ppm
S (%)	1,97	-
Fe (%)	1,06	5596 ppm
Mn (%)	0,08	324 ppm
Na (%)	0,06	-
C/N	14	12
C-organic (%)	15.58	14,50
N- organic (%)	-	1,08
$N-NH_4$ (%)	-	0,14
$N-NO_3$ (%)	-	0,04
Water content (%)	27.52	45,46
Cation Exchange capacity	30.41	32,23

Source: Tatipata and Jacob, 2012

Note: - is not analyzed

Plant Growth

The effects of compost on growth performance of the plants as measured by the plant height, leaf number, leaf area of the corn and the pakchoy are reported in Table 2, Tabel 3 and Table 4, respectively. The analysis of plant height, leaf number, leaf area both of sticky white corn and leaf number and leaf area of pomegranate corn were significant at the 5% level. 15 t ha^{-1} sago waste compost provide higher corn growth, while 250 compost from city organic waste provide higher of pakchoy growth.

TABLE 2 THE EFFECT OF COMPOST DOSAGE ON HEIGHT PLANT, LEAF NUMBER, LEAF AREA ON PULUT COR

Compost dosage(t ha^{-1})	Pulut Corn		
	Plant Height (cm)	Leaf Number	Leaf Area (cm²)
0	58.96 a	6.25 a	263.36 a
7,5	100.08 ab	7.17 a	344.28ab
10	104.33 b	7.33 a	372.80 ab
12,5	110.25 b	7.42 a	419.33 ab
15	123.18 b	9.08 b	524.80 b

1,ab,b,b means number followed by the same letter within the same column did not different significantly at 5% of DMRT

TABLE 3 THE EFFECT OF COMPOST DOSAGE ON HEIGHT PLANT, LEAF NUMBER, LEAF AREA ON DELIMA CORN

Compost dosage (t ha^{-1})	Delima Corn		
	Plant Height (cm)	Leaf Number	Leaf Area (cm^2)
0	130,00 a	8,83 a	285,87 a
7,5	133,08 a	9,92 ab	356,93ab
10	153,33 a	10,17 ab	377,17 ab
12,5	154,50 a	10,33 ab	427,63 ab
15	158,25 a	10,92 b	529,13 b

1,ab,b,b means number followed by the same letter within the same column did not different significantly at 5% of DMRT

TABLE 4 THE EFFECT PF CITY ORGANIC COMPOST ON HEIGHT PLANT, LEAF NUMBER, LEAF AREA ON PAKCHOY

Compost dosage (g $polybag^{-1}$)	Plant Height (cm)	Leaf Number	Leaf Area (cm^2)
0	17.50 d	4.00 e	273.8 e
100	28.17 c	5.00 d	503.7 d
150	31.00 b	5.33 c	670.2 c
200	32.17 b	6.00 b	789.4 b
250	40.00 a	7.00 a	995.3 a

1,ab,b,b means number followed by the same letter within the same column did not different significantly at 5% of DMRT

Nutrients in organic matter must be released by soil microorganisms through a decaying process called mineralization. This biological process is affected by variations in moisture, temperature, and the microbial species and populations present in the soil. Therefore, organic materials are far less predictable in nutrient content, nutrient release, and nutrient-use efficiency than commercial grade fertilizers. Organic materials can serve as effective and environmentally sound fertilizer materials only if their nutrient contents are known and their mineralization rates are estimated closely. The soil is a living system. as well as the particles that make up the soil, it contains millions of different creatures. These creatures are very important for recycling nutrients. C-organic of compost from sago waste and city organic waste were 15,58% and 14,50% can increase C-organic soils that generally low (Kartini, 2000). Higher C-organik of soil can improves the structure of soil. This allows more air into the soil, improves drainage and reduces erosion.and improve soil's ability to hold water (Lingga and Marsono, 2006). Feeding the soil with manure or compost feeds the whole variety of life in the soil which then turns this material into food for plant growth. Organic amendments are often applied to soils to increase crop productivity, crop quality (Bresson et al. 2001; Edmeades 2003; Risse et al. 2001).Composted manure increased corn crop growth rate (CGR) leaf -N concentration, leaf area index (LAI), and, in one of two years, net assimilation rate (NAR). Composting swine hoop manure before field application appears to be an effective alternative to fresh-manure application for corn production (Terrance et al., 2004) Application of manure or composted manure can increased soil concentrations of nutrients and organic matter (Chang et al., 1991; Eghball, 2002). Soil organic matter can improving root plant uptake of water and nutrients, and can dissolve minerals within the soil, leaving them available for plant roots. It also helps make a good environment for all the soil microbes and organisms that work with and enhance a plant's health and growth. N-mineralization from organic matter depend on C/N ratio. The lower C/N ratio, the higher nutrients and mineral dissolved. C/N ratio of compost from sago waste and city organic waste were 14 and 12, respectively. It was optimum C/N ratio. Plant height, leaf number and leaf area of the two corn and pakchoy that applied with 15 t ha^{-1} of sago waste compost and 250 g per polybag of city organic waste were resulted in high content of nutrition. More or less nutrients available for plant through root absorption reflected the increase in cation exchange capacity (CEC). CEC suggests high amount of available minerals in the compost. Available minerals are very essential for plant growth and development. The higher the CEC, the higher the negative charge and the more cations that can be held. The. CEC of sago waste and city organic waste were 30,41 and 32,23, respectively. Organic matter can improve the structure of all types of soils, from loose structure to crumbs structure and increase soil aeration. Residual effects of compost application can maintain crop yield level for several years after manure or compost application ceases since only a fraction of the N and other nutrients in compost become plant available in the first year after application (Motavalli et al., 1989; Eghball et al., 2002). Power (1999) found that 40% of beef cattle feedlot manure N and 20% of compost N were plant available in the first year after application, indicating that about 60% of manure N and 80% of compost -N became plant available in the succeeding years, assuming little or no loss of N due to NO_3–N leaching or denitrification. Residual effects of organic materials on soil properties can contribute to improvement in soil quality for several years after application ceases (Ginting et al., 2003). According to Sunarto and Suwardi (2010), The higher of corn plant was improved after add 1.5 t ha^{-1} and 1,0 t ha^{-1} of chicken manure. On the other hand, add 6,06 ml $water^{-1}$ liquid compost can increase the highest of pakchoy (Barus, 2011). Increased N, P, K, pH, and C levels in the soil can increase crop yield.

Plant Production

The effect of compost on corn ears per plot, length and diameter of ear, and dry grain shelled weight of the corn plant are reported in Table 5 and Table 6, while the effect of compost on pakchoy fresh weight is reported in Table 7.

TABLE 5 EFFECT OF SAGO WASTE COMPOST ON LENGTH, DIAMETER, WEIGHT OF EAR AND WEIGHT OF DRY SHELLED GRAIN ON PULUT CORN

Compost dosage (t ha^{-1})	Pulut Corn			
	Ear Length (cm)	Ear Diameter (cm)	Ear Weight (g)	Weight of Dry Shelled Grain (g)
0	13,49 a	2,74 a	44,23 a	40,28 a
7,5	15,36 ab	3,09 a	53,15 a	41,72 a
10	15,58 ab	3,28 a	58,87 a	46,17 a
12,5	16,87 b	3,50 a	61,83 a	47,76 a
15	17,28 b	4,14 a	62,14 a	52,63 a

1,ab,b,b means number followed by the same letter within the same column did not different significantly at 5% of DMRT

TABLE 6 EFFECT OF SAGO WASTE COMPOST ON LENGTH, DIAMETER, WEIGHT OF EAR AND WEIGHT OF DRY SHELLED GRAIN OF THE PULUT CORN

Compost dosage (t ha^{-1})	Delima Corn			
	Ear Length (cm)	Ear Diameter (cm)	Ear Weight (g)	Weight of Dry Shelled Grain (g)
0	14,94 a	2,99 a	44,23 a	41,67 a
7,5	16,61 ab	3,42 a	53,15 a	42,42 a
10	16,86 ab	3,55 a	58,87 a	47,19 a
12,5	17,82 b	3,75 a	61,83 a	48,68 a
15	18,18 b	4,90 a	62,14 a	53,56 a

1,ab,b,b means number followed by the same letter within the same column did not different significantly at 5% of DMRT

TABLE 7 EFFECT OF CITY ORGANIC COMPOST ON FRESH WEIGH OF THE PAKCHOY

Compost dosage(g polybag^{-1})	Fresh Weight (g)
0	18.87 e
100	67.78 d
150	81.11 c
200	90.00 b
250	100.00 a

1,ab,b,b means number followed by the same letter within the same column did not different significantly at 5% of DMRT

The analysis of ear length of pulut corn and delima corn and the fresh weight were significant at the 5% level. The other variables were not significant. However, increasing the compost dosage (15 t ha^{-1} for corn plant and 250 g for pakchoy), increase both growth and production of the two plants. *Brassica sinensis* that applied with compost was higher than that not applied with compost (Pratomo dan Rohin, 2011). Green manures are manure from plants with high nitrogen content and the nitrogen of green manure adds nitrogen in soil. Nitrogen in soil organic matter becomes available to plants through mineralization. Conditions that favor high yields also favor the activity of soil microorganisms that are responsible for mineralization. Therefore, estimated for N released from organic matter are related to expected yields. Vermicompost tea can positively influence plant yield and quality of pakchoy and increase soil biological activity in multiple soil types (Pant et al., 2011).

Compost amendment increased corn whole-plant P and K uptake 19 and 21%, averaged across 2 years. No-tillage increased whole-plant P uptake 1 year compared to MP and CT (113 vs. 65 kg ha^{-1}) and increased grain P concentration (3.1 vs. 1.5 g kg^{-1}) (Singer et al, 2007). 0.5 NPK + 0.5 MSW1 gave the best plant growth, health and yield for potato and corn

Nitrogen (N) is important for growth and development of plant, and of the macronutrients, is often the one that is most limiting. Soil nitrate (NO_3^-) and ammonium (NH_4^+) are both forms of inorganic nitrogen that are readily available for use by plants. They are formed from the mineralization (by microorganisms) of organic forms of N such as soil organic matter, crop residue, and manures. The content of plant available nitrogen is important to assure that the crop has enough for adequate growth. Nitrogen is a major part of chlorophyll and the green color of plants. It is responsible for lush, vigorous growth and the development of a dense, attractive lawn. (Burke, 2011). Chlorophyll is a pigment which function in photosynthesis. Increasing of nitrogen in soil, increased photosynthesis, so plant produced many assimilate. The assimilate can improve plant growth and production. Nitrogen is building block amino acid, amide and nucleoproteins which function in divide, enlargement and differentiation of cell, so improve plant growth. Plant growth is a increase size, volume, weight and cell number (Salisbury and Ross, 1995).

Phosphorus is a component of the complex nucleic acid structure of plants, which regulates protein synthesis. Phosphorus is, therefore, important in cell division and development of new tissue. Phosphorus is also associated with complex energy transformations in the plant.(USDA NIFA, 2013). Barber at Purdue University indicates phosphorus uptake is largely a function of size and nature of the root system, rate of water absorption, amount of phosphorus in the soil, and ability of the soil to supply phosphorus to the soil solution.

Potassium (K) is an essential plant nutrient, because it is required in large amounts by plants. Potassium is a vital component of numerous plant functions, including nutrient absorption, respiration, transpiration, and enzyme activity (USDA, 2013).

Other nutrients such as magnesium (Mg), calcium (Ca) contributed to growth and production of corn and pakchoy. Mg is a component of chlorophyll, while Ca can straighten up cell permeability.

Conclusions

Organic farming system can develop in Maluku through using local bio resources such as sago waste and city organic waste to compost. The compost can applied on local plant such as sticky white corn (pulut corn) and pomegranate corn (delima corn) as well as pakchoy to increase growth and production. Organic farming entails an emphasis on biodiversity of the agricultural system and the surrounding environment, reduction of external and off-farm inputs and elimination of synthetic pesticides and fertilizers and other materials, renewable resources, soil and water conservation, and management practices that restore, maintain and enhance ecological balance, human consume healthy food.

ACKNOWLEDGEMENTS

The research was funded by Direktorat Penelitian dan Pengabdian Kepada Masyarakat (DP2M) DIKTI Jakarta, Indonesia.

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