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Titonia Utilization and The Rest Of Soybean Harvest In The Alternative As Fertilizer Ultisol Fertility Improvement And Soybean Crop Production

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ABSTRACT

Utilization Titonia and soybean crop residues (straw soybean) as compost, is one alternative fertilizer to improve soil fertility Ultisol. This study aimed to determine the effect of a mixture of compost and straw Titonia soy, lime and fertilizers in improving soil fertility and soybean crop production. The research was conducted at experimental field LimauManis and laboratory analysis conducted at the Laboratory P3IN Andalas University, Padang. Research using Random Design (RBD), which consists of 10 treatments with 3 replications were tested. The results showed that administration of lime, compost and fertilizers give effect to the chemical characteristics Ultisol namely against soil pH value, the content of N, P and K soil. The provision of artificial fertilizers as much as 50% of the soybean crop needs, provide higher impact than that of artificial fertilizers as much as 25% of the increase in soil fertility and the growth and production of soybean plants. Production of dry seeds of soybean highest weight obtained amounted to 1.85 tons / ha in the treatment of lime dolomite 500 kg / ha + compost mixture (5 tons Titonia/ha with 5 tons of soybean straw/ha) + NK fertilizers by 50% of the soybean crop needs (treatment G).

1. Introduction

Agricultural development in Indonesia aims to increase agricultural production and farmers' income, as well as to maintain and conserve natural resources. The use of artificial fertilizers are continuously being offset by organic matter, have shown an adverse impact on the environment. The use of artificial fertilizers clearly provides a very quick response and great improvement in agricultural production when compared with organic matter. However, the purchasing power of farmers to fertilizers lower due to the increased price of fertilizers continues to increase from year to year, while farmers are very limited capital. Therefore, the use of artificial fertilizers should be reduced without reducing the production. One attempt to do is to use alternative fertilizers. Referred to as alternative fertilizer in this

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case is the use of fertilizer materials derived from natural and renewable.

Efforts during this agricultural expansion leads to less productive land or marginal land. Ultisol is the largest marginal land in Indonesia is about 45.8 million ha or 24.3% of the land area of Indonesia (Subagyo et al., 2000). Subagyoet. al., (2000) also noted that in the five major islands in Indonesia, the largest land occupied Ultisol like Sumatera area of 9.5 million hectares, 21.9 million hectares of Kalimantan, Irian Jaya and Maluku 8.9 million ha and in Sulawesi 4.3 million ha. Hakim *et al*., (1986) stated that Ultisol tremendous potential for expansion and improvement of agricultural production if managed appropriately.

Expansion and improvement of agricultural production in Ultisol encountered some problems, such as low pH, the content of Al is high enough even to poison plant growth (Hakim, 1982). In addition, some nutrients become unavailable on Ultisol such as P, Ca, Mg and Mo, Fe and Mn while the element is quite high, and often cause toxicity to plants (Nyakpa*et. al*., 1988). Feature Ultisol among others has a pH value of about 4-4.5 with organic matter content and CEC were lower. Furthermore Jamilah (1996) reported that the nutrient content in Ultisol in West Sumatra include the following: soil pH from 4.45 to 5.00, high Al saturation between 46-75%, P availability is very low at 1.43 to 2, 51 ppm, a total of 0.12 to 0.27% N, low base saturation of about 8-18% and organic C from 0.78 to 2.24%. Besides a low nutrient content, soil physical properties as well as stability and aggregation ugly soil structure less stable, due to the lack of organic matter, and cause a great threat of erosion. Moreover, when an error occurs on land management Ultisol.

Based on some of the obstacles mentioned above, in order to utilize Ultisol, should be accompanied by efforts liming fertilizing. In principle, of lime on Ultisol is to increase the soil pH and reduce the saturation of Al were poisoned, as well as increase the availability of plant nutrients, especially nutrients P, so appropriate for optimal plant growth called calcification technology (Hakim, 2006). The use of lime in Ultisol had brought many changes in the repair and improvement of crop yields. Lime 2-6 tonnes / ha can increase the production of food crops such as rice, crops (maize and beans) varied from 50% to 400% (Hakim, 1982 and Nyakpa et al., 1988). To reduce the use of artificial fertilizers in large quantities, it can be done with organic matter which may reduce the need for artificial fertilizers and improve the nutrient content in Ultisol. Organic materials can be manure, green manure and compost. In addition to containing nutrients required by plants, organic materials also can improve the physical, chemical and biological soil.

Titonia is one shrub (weeds) rather than the family Asteraceae which allegedly came from Mexico, branched very much, trunked soft and rather large, growing very rapidly, so that in a short time can form a dense bush. Jama*et. al*., (2000) suggest that the leaves of weeds Titonia contains nutrients is high at 3.5-4.0% N; 0.35 to 0.38% P; 3.5 to 4.1% K; 0.59% 0.27% Ca and Mg. Therefore, these plants can be used as a source of nutrients, especially N and K. Sanchez and Jama (2000) reported that in Kenya Titonia can grow quickly with the results of the dry biomass of about 2-5 tonnes/ha/year. Titonia farmed by the Hakim and Agustian (2003, 2004 and 2005) can generate as much as 30 tons of fresh or 6 tons of dry matter per year, with a land area of about 1/5 ha. Nutrient content in Titonia in West Sumatra are as follows: 2.1-3,92% N; 0.3 to 0.56% P; 1.6 to 2.82% K; 0.24 to 1.8% Ca and 0.28 to 0.87% Mg, C/N of about 20 and about 10% lignin that deserve to be green manure.

Titonia be trimmed every two months and in certain circumstances, the staple crop does not need it, Titonia can be composted. Besides, it also can take advantage of the remaining harvest of soybeans (soybean hay) in the previous crop season to be returned to the land in the form of compost as an alternative to reduce the need for artificial fertilizers. To speed up the composting Titonia, can use biological agents available on the market, such as Orgadec, EM4 (Effective Microorganisms) and stardec. Orgadec been used in the manufacture of compost derived from oil palm empty fruit bunches. With the use of the Orgadec activator, the composting process oil palm empty fruit bunches only lasts for 14-21 days. Earlier if no activator Orgadec

composting process can take between 12-18 months (Indriani, 2013). Furthermore EM4 solution for composting has been widespread use since proven to accelerate the composting process. The fermentation process of composting with EM4 anatara may take 4-7 days (Indriani, 2013). Stardec been used in composting manure in Situjuh District Lima PuluhKoto.

Crops that need attention recently is the soybean crop, because the needs of the growing food crops, while production is still low, so it is still imported. Therefore, it takes effort to increase soybean production with a variety of alternatives, such as the use of compost Titonia to reduce the use of artificial fertilizers without reducing the number of production and also for the improvement of soil fertility Ultisol.

Based on the above, the purpose of this study was to determine the effect of a mixture of compost and straw Titonia soy, lime and fertilizers in improving soil fertility and soybean crop production.

2. Materials and Methods

The research was conducted at the Experimental Station Limau Manis and laboratory analysis carried out at the Laboratory P3IN Andalas University, Padang. Titonia raw materials used are pruned from the Experimental Field LimauManis and soybean straw coming from the rest of the soybean crop in the previous growing season. Biological agent used is packed with brand Orgadec (5 kg/ton), EM4(1 L/ton) and stardec (2 kg/tonne). Besides, it also can use dolomite lime and artificial fertilizers.

Doses of artificial fertilizers used in these experiments was as follows: 100 kg urea/ha (45 kg N/ha), 100 kg KCl/ha (50 kg K/ha), 100 kg SP36/ha (36 kg P2O5/ha) , 100 kg kiserit/ha (27 kg MgO/ha) and 500 kg of lime/ha. Effect of nitrogen fertilizer, and KCl in accordance with the treatment, while the SP36 and Kieserite according soybean crop needs.Kapur is given to all test plots. For pest and disease control is Dithane M-45, Curater and Leybacid.

This study uses a randomized block design (RAK) with some of the treatment mixture of compost and biological agents. Compost made from compost comprising A, B, C, D and E. For compost A, B, C and D were made six replications because at the time will be used in the cultivation of soybean crops in the field, there are differences in the provision of the amount of artificial fertilizer is 25% and 50% of the crop needs while treatment E only 3 replicates for only artificial fertilizer added as much as 50%, so that there are 27 units in the composting experiment. The amount of material used in the manufacture of compost Titonia, Titonia + straw soybeans and soybean straw alone with some biological agent can be seen in Table 1.

Table 1. The amount of material in a composting mixture Titonia with soybean straw

Treatment Code	Number Titonia (tonnes/ha)	Number Titonia (kg/ plot)	Soybean straw (tonnes/ ha)	Soybean straw (kg/plot)	Biological agents are given
A	10	16	0	0	Orgadec
B	10	16	0	0	Stradec
C	10	16	0	0	-
D	5	8	5	8	EM4
E	0	0	10	16	EM4

Lime is done for all experimental plots of 800 g/plot or equal to 500 kg/ha and not as a treatment except control treatment (without giving lime). For soybean crop fertilization in the field can be seen in Table 2.

Treatment Code	Treatment					
	Type compost	Urea (g/plot)	KCl (g/plot)	SP 36 (g/plot)	Kiserit (g/plot)	Description
A	Compost A	80	80	160	160	NK 50 % Cn
B	Compost A	40	40	160	160	NK 25 % Cn
C	Compost B	80	80	160	160	NK 50 % Cn
D	Compost B	40	40	160	160	NK 25 % Cn
E	Compost C	80	80	160	160	NK 50 % Cn
F	Compost C	40	40	160	160	NK 25 % Cn
G	Compost D	80	80	160	160	NK 50 % Cn
H	Compost D	40	40	160	160	NK 25 % Cn
I	Compost E	80	80	160	160	NK 50 % Cn
O	Without	0	0	0	0	Without

Description: NK = Fertilizer N and K, Cn = the crop needs

3. Results and Discussion

3.1. Effect of lime and compost Titonia to changes in pH value of the soil, the availability of nutrients N, P and K on Ultisol

Before planting soybeans in the field, do the

initial soil sampling for all the experimental plots. Furthermore, the land was given compost along with lime and incubated for 2 weeks. After 2 weeks of incubation with lime and compost samples were taken back to be analyzed nutrient content of the soil that will be used for soybean cultivation. The results of initial soil analysis and after incubation for 2 weeks are presented in Table 3.

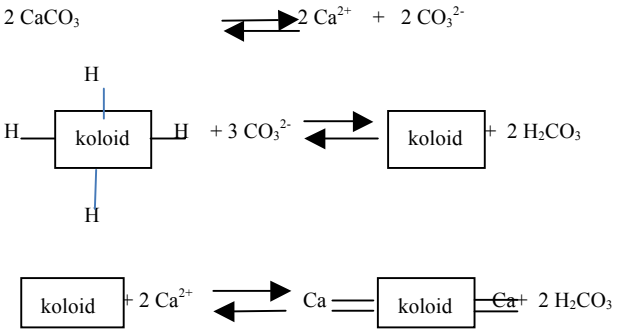
Table 3. The results of the soil analysis before and after given a variety of treatments for soybean cultivation in the field

Code	pH		N (%)		P (ppm)		K (me/100 g)	
	Bfr	Afr	Bfr	Afr	Bfr	Afr	Bfr	Afr
A	5,53	6,24	0,35	0,49	53,15	64,12	0,35	0,41
B	5,56	5,88	0,23	0,33	50,73	59,26	0,27	0,41
C	5,57	6,13	0,25	0,34	47,11	74,64	0,27	0,48
D	5,57	5,96	0,25	0,31	73,42	76,87	0,24	0,51
E	5,61	6,05	0,27	0,30	52,62	62,69	0,23	0,46
F	5,33	5,92	0,22	0,32	41,16	62,60	0,23	0,42
G	5,34	6,81	0,15	0,29	59,56	75,48	0,17	0,41
H	5,42	6,62	0,27	0,36	46,04	55,24	0,34	0,42
I	5,39	6,47	0,28	0,43	46,48	86,31	0,35	0,48
L	5,49	5,98	0,31	0,31	40,26	40,26	0,25	0,25
Average	5,48	6,21	0,26	0,35	51.05	65,75	0,27	0,43
O	5,27	5,27	0,16	0,16	23,43	23,43	0,14	0,14

Description: Bfr= Before Afr = After

Based on the data in Table 3 shows that with the provision of compost and lime give effect to the pH value of the soil and the content of N, P and K soil to be used for the cultivation of soybean crops in the field. From the table shows that an increase in the pH value of the soil due to various treatments by 0.73 that of the average value of 5.48 becomes 6.21. Lime will be bonding between CO32- ions derived from lime with H + ions so that will reduce the amount of H + ions that causes an increase in the pH of the soil. This pH increase due to the provision of lime and compost.Hakim (2006) states that the calcification is an effort to improve the productivity of acid soils. Through liming, aluminum toxicity can be reduced so as to increase the soil pH followed by increased availability of soil nutrients. If the acidity caused by saturated soil colloids by ion H, then the reaction of lime in neutralizing soil acidity as the reaction below.

Furthermore Hartatik and Adiningsih (1986) suggest that the organic matter in the soil, either in the form of compost, manure or green manure can improve soil CEC, soil pH, lower aluminum can be exchanged. Added by Setijono (1996) states that the decomposition of organic materials emit organic acids that will affect the pH of the soil. Besides it is also the result of decomposition of organic matter produces cations of bases K +, Na +, Ca 2+, Mg 2+ and others that will increase the soil pH.Utomo*et. al*., (2015) stated that the organic matter in the soil, either in the form of compost, manure or green manure can improve soil CEC, soil pH, lower aluminum can be exchanged. Results of research Son (2016) states that the provision of Titonia compost 5 tons/ha can increase the pH from 7.14 to 7.27. This is in line with the statement Hartatik (2007) which states that the plant Titonia is a type of weed that can grow disembarang place. This plant contains high nutrients, especially N and K at 3.5% N, 4.1% K and 0.38% P, one of which serves to increase the soil pH.



Of lime and organic matter causes an increase in the percentage of land N of 0.09% from an average of 0.26% to 0.35%. This is due to an increase in soil pH affects the activity of soil microorganisms. Increased activity of the microorganisms will improve the process of decomposition of organic matter. Decomposition of organic material will release existing N content in the compost so that an increase of N in the soil. This is consistent with the statement Suwahyono (2015) which suggest that adding compost to soil can serve as an energy source for soil microorganisms. Biological properties of soil improvement occurred because of the increasing population of the diversity of soil microorganisms. Aris (2015) states that the granting of Titonia compost, bark coffee and rice straw can increase soil total N of 0.21 to 0.35% N. Sedjati (2005) states that the increase in soil N is caused by bacteria and

microorganisms present in compost , so as to remodel a given organic material into the soil. Hairiah (1996) adds that the organic material is one component of soil is very important for the soil ecosystem, where organic matter is a source and a binder nutrients and as a substrate for soil microorganisms. Benefits of organic material benefit, among others, provide the bulk of the N, P, K and S, increase the cation exchange, soil pH, and buffering capacity. ,

Of lime and compost led to an increase in soil P content for their improvement Ultisol chemical properties, especially soil pH.The increase in the P content of 14.75 ppm from the average value of 51.05 ppm to 65.75 ppm as a result of lime and compost. Of lime will increase the pH of the soil and also reduce the amount of aluminum that can be interchanged so that the soil P will be released. Furthermore, organic matter will release organic acids that can reduce the activity of the aluminum that is exchanged by forming chelate so that nutrients P bound by aluminum can be separated so as to increase soil P content. This is in line with the statement Setijono (1996) and Hardjowigeno (2003) states that the organic acids produced during the decomposition process can react with ions of Al and Fe form a complex that is insoluble to soluble aluminum decreased and pH increased with the expected increase in soil P availability. Furthermore Palm *et. al*., (1997) adds that soil microorganisms will produce phosphatase enzymes which are compounds perombak organic P into P inorganic. This phosphatase enzyme can decompose P apart from the organic matter is added, it can also decipher P derived from soil organic matter. Son (2016) states that the granting of Titonia compost and rice straw compost to give effect to the number of grains of rice, the percentage of filled grain of rice, the percentage of empty grain of rice and a weight of 1000 grain. The best results found in the combination treatment Titonia composting as much as 5 tons/ha of straw and compost as much as 5 tons/ha.

Giving Titonia compost that contains K causes an increase in K content of soil. Increased soil K content of 0.16 me/100 g soil of an average value of 0.27 me/100 g soil to 0.43 me/100 g soil. Increased soil K content can be derived from the decomposition of compost materials that contain lots Titonia K. It was not separated from the activity of soil microorganisms and the increased influence of soil pH.Changes in soil pH has also brought changes to the availability of soil K that will increase the availability of soil K for the growth and production of soybean plants. Titonia contains nutrients N and K are high making it suitable to be used as compost. Sufficient nutrient availability and environmental conditions favorable for the cultivation of soybeans, is expected to provide growth and production of soybean crops are good also.

3.2. Effect of lime, compost and fertilizers on the growth and yield of soybean

The observations and measurements that have been done on the growth of soybean plants with parameters plant height and weighs 100 soybean plants in the form of dry beans and dry beans per hectare are presented in Table 4.

Table 4. Plant height, weight of dry seeds, and weight dry beans per hectare of soybean

Code Treatment	Plant height (cm)	Weight 100 dry seeds (g)	Weight of dry beans (tons/ha)
A	62,00 b	18,39 b	1,61 b
B	60,46 b	17,25 b	1,43 b
C	64,53 b	17,38 b	1,51 b
D	58,57 b	17,02 b	1,14 b
E	65,47 b	18,41 b	1,63 b
F	64,67 b	18,67 b	1,71 b
G	63,80 b	18,88 b	1,85 b
H	62,86 b	17,18 b	1,40 b
I	60,47 b	17,94 b	1,56 b
L	64,27 b	17,12 b	1,19 b
O	35,73 a	11,86 a	0,25 a

Description:
The figure followed by the same letter in the same column, showed no significant differences in the level of HSD 5%

Based on the test results HSD, the observed data growth and yield of soybean in Table 4, was statistically demonstrated that all parameters observed were plant height, weight of 100 seeds dry weight of dry beans per hectare, showed no significant differences between all treatment combinations except with control treatment (treatment O). Giving compost is produced using biological agents (treatment A, B, C, D, G, H and I) and compost without the administration of biological agents (treatment E and F) did not show significant differences. This ni is due to the raw materials used

for making compost easy decaying so it does not require biological agents in the composting process. Hakim and Agustian (2003, 2004 and 2005) states that the morphological Titonia among others have stems that gently resembles legume, so easily weathered and highly branched with the content of the C/N material of about 20 and contains ligninnya about 10%, in addition to a water content of up to 500 % so easily rot and crumble. Indriani (2013) adds that the factors that affect composting that material used, the size of the material, the material composition, the number of microorganisms, moisture and aeration as well as temperature and acidity.

Likewise, the provision of 100% of artificial fertilizer (treatment H) does not show the other treatments except the control treatment (treatment O). Provision of substitution of artificial fertilizers by 25% of the soybean crop needs (B, D, F and H) and 50% of the soybean crop needs (treatment A, C, E, G and I) also showed no statistically significant differences. This provides information that the composting Titonia alone or mix with soy straw as much as 10 tonnes/ha and the provision of artificial fertilizers as much as 50% of the needs of the soybean crop results were not significantly different from the provision of compost as much as 10 tonnes/ha and artificial fertilizers as much as 25% of the soybean plants. So also with the provision of artificial fertilizer as much as 100% of the soybean crop needs.

The measurement results of growth and production of soybean in Table 4, all treatments were not statistically showed no significant differences except the control treatment (treatment O) for all the meters were observed were plant height, weight of 100 seeds dry weight of dry beans per hectare of soybean plants , This shows that with the provision of compost, lime and artificial fertilizers have been able to increase the availability of nutrients to support the growth and yield of soybean. By administering lime, compost and fertilizers by 25% and 50% of the soybean crop nutrient needs to not show a statistically significant difference. This is due to the residual effects of the previous growing season which causes nutrient content of soil can support the growth and production of soybean crops because the land is already planted before. Besides, also, the effect of granting lime, compost and fertilizers that will provide sufficient amounts of nutrients for the growth and yield of soybean. Wahyono*et. al*., (2011) states that the use of compost can improve soil chemical properties include soil pH, CEC and mineral content in the soil. This is in accordance with the opinion of the Hakim and Agustian (2005) adds that the provision Titonia K dd role in improving the soil. Further Anas (1988) adds that with organic matter such as compost with a rate of 20 tonnes/ha can increase the absorption of nutrients and the growth of the corn crop soybeans during two cropping seasons. Furthermore, the Putra (2016) adds that the composting Titonia 5 tons / ha can increase soil pH from 7.14 becomes 7.27 to 7.61. This is in line with the opinions Hartatik (2007) which states that the plant Titonia is a type of weed that can grow disembarang place. This plant contains high nutrients, especially N, K and K at 3.5% N, 0.38% P and 4.1% K which serves to increase the soil pH. Besides it is also the Putra (2016) states that the provision of compost Titonia 2.5 tons/ha will lead to an increase in P of 0.73 -1.38 ppm. Giving compost will improve soil microbial activity which will issue a phosphatase enzyme to break down the organic P into P inorganic. The enzyme can decompose P from organic materials provided. With the improvement of the chemical characteristics of soil and soil fertility improvement Ultisol, will have an impact on the availability of nutrients for growth and production of soybean plants.

In comparison, with the provision of lime, compost and fertilizers can increase the uptake of N, P and K in maize. The adequacy of nutrients for growth and production of corn will have an impact also on the weight of dry straw. Low-Ogbomo and-Ogbomo Law (2009) states that the NPK fertilizer significantly increased the growth of corn plants, plant dry weight and seed yield of corn. Kasno research results and Rostaman (2013) which states that the NPK fertilizer will increase the absorption of N, P and K, the higher uptake via maize corn kernels than berangkasan. Furthermore Subhan (2016) adds that the provision of filter cake compost and rice straw compost significant effect on N uptake as a single factor, while the uptake of N and P occurs in the interaction of the two. By composting blotong significant effect on the weight

of the corn crop dry berangkasan.

From the data in Table 4 show that the administration of artificial fertilizer as much as 100% of the soybean crop needs (treatment I) yields are lower than the provision of compost added with 50% of the soybean crop needs artificial fertilizers. The highest yield of soybean dry seed weight is 1.85 tons/ha found in composting mixture (between plant Titonia 5 tons/ha with soybean straw as much as 5 tons/ha), dolomite lime as much as 500 kg/ha and the provision of artificial fertilizer NK much 50% of the soybean crop needs (treatment G).

4. Conclusions

From the research that has been carried out, it can be concluded as follows:

1. Provision of lime, compost and fertilizers give effect to an increase in soil chemical characteristics Ulltisol by increasing the pH value of the soil, the content of N, P and K as well as the production of soybeans.
2. Giving compost is produced using biological agents and biological agents is not without significant effect on the growth and yield of soybean. That is composting Titonia not require biological agents to accelerate the composting process because the material is easily weathered.
3. The results of the highest soybean dry seed weight of 1.85 tonne/ha of lime dolomite obtained at 500 kg/ha + compost mixture (5 ton/ha Titonia with 5 tons/ha of soybean straw) as well as artificial fertilizer NK + 50% of the soybean crop needs (treatment G).

References

Anas, I. 1988. Effect of Humotex on Growth of Maize Laboratory of Soil Biology. Bogor Agriculture Institute, Bogor. 62 halaman.

Aris, M. 2015. Penggunaan kompos titonia , kulit kopi dan jerami padi untuk perbaikan sifat kimia tanah dan peningkatan hasil padi sawah (*Oryzasativa*, L) di dataran tinggi Aceh Tengah, Tesis. Program Studi Konservasi Sumberdaya Lahan, Pascasarjana Universitas Syiah Kuala, Banda Aceh. 69 halaman.

Hakim, N. 1982. Pengaruh Pemberian Pupuk Hijau dan Kapur Pada Tanah Podsolik Merah Kuning terhadap Ketersediaan Fosfor dan Produksi Tanaman Jagung, Disertasi, Fakultas Pascasarjana IPB. Bogor. 272 halaman.

Hakim, N. ; M. Y. Nyakpa., A. M. Lubis., S. G. Nugroho., M. R. Sal., M.A. Diha., Go Ban Hong., N. H. Bailey. 1986. Dasar-dasar Ilmu Tanah. Universitas Lampung. Lampung. 486 halaman.

Hakim, N dan Agustian. 2003. Gulma tithonia dan pemanfaatannya sebagai sumber bahan organik dan unsur hara untuk tanaman hortikultura. Laporan Penelitian Hibah Bersaing XI/I Perguruan Tinggi Tahun Anggaran 2003. Fakultas Pertanian Universitas Andalas Padang. Halaman 80-89.

Hakim, N dan Agustian. 2004. Budidaya gulma tithonia dan pemanfaatannya sebagai bahan substitusi pupuk buatan untuk tanaman hortikultura di lapangan. Laporan Penelitian Hibah Bersaing XI/II Perguruan Tinggi Tahun Anggaran 2004. Fakultas Pertanian Universitas Andalas Padang. 65 halaman.

Hakim, N dan Agustian. 2005. Budidaya tithonia dan pemanfaatannya dalam usaha tani tanaman hortikultura dan tanaman pangan secara berkelanjutan pada Ultisol. Laporan Penelitian Hibah Bersaing XI/III Perguruan Tinggi Tahun Anggaran 2005. Fakultas Pertanian Universitas Andalas Padang. 61 halaman

Hakim, N. 2006. Pengelolaan Kesuburan Tanah Masam dengan Teknologi Pengapuran Terpadu. Andalas University Press. Padang. 204 halaman.

Hairiah, K. 1996. Detoksifikasi Aluminium oleh Bahan Organik : Strategi bagi Sistem Pertanian dengan Masukan Rendah pada Tanah Masam. Jurnal Universitas Brawijaya Vol 8 No 3 : Ilmu-Ilmu Hayati.1 9-36.

Hardjowigeno, S. 2003. Ilmu Tanah. Akademi Presindo, Jakarta. 286 halaman.

Hartatik, W. 2007. *Tithonia diversifolia* Sumber Pupuk Hijau. Warta Penelitian dan Pengembangan Pertanian. Bogor. Vol. 29, No. 5, 2007, halaman 11-16.

Hartatik, W dan J. S. Sri Adiningsih. 1986. Pengaruh pemberian kapur dan pupuk hijau pada tanah podzolik Sitiung terhadap produksi kedelai di rumah kaca. Pusat Penelitian Tanah, Bogor. 46 halaman.

Indriani, Y. H. 2013. MembuatKomposSecaraKilat. PenebarSwadaya. Jakarta. 62 halaman.

Jama, B. A; C. A. Palm; R. J. Buresh; A.I. Niang; C. Gachengo; G. Nziguheba and M. Amadalo. 2000. *Tithonia diversifolia* green manure for soil fertility improvement in Western Kenya ; A. Review. Agroforesty System Nairobi. 49 : 201-221.

Jamilah. 1996. Peranan *Sesbaniatrostrata* dan tahap pemberian pupuk N terhadap efisiensi pemupukan N dan Hasil jagung pada Ultisol dengan perunut ^{15}N, Tesis. Program Pascasarjana Universitas Andalas, Padang. 251 halaman.

Kasno, A dan Rostaman, T. 2013. Serapan hara dan peningkatan produktivitas jagung dengan aplikasi pupuk NPK majemuk. Balai Penelitian Tanah. Halaman 179-186.

Low Ogbomo, K.E and J.E. Low-Ogbomo. 2009. The performance of *Zea mays* as influenced by NPK fertilizer application. Not, Sci. Biol (1) :59-62.

Nyakpa, M. Y., A. M. Lubis.,M. A. Pulung., G. Amrah., A. Munawar., Go Ban Hong dan N. Hakim. 1988. Kesuburan Tanah. Penerbit Universitas Lampung. Lampung. 258 halaman.

Palm, B.A; R.J.K. Myer and S.M. Nandwa. 1997. Combined use of organic and anorganic nutrient sources for soil fertility maintenance and replenisment *In* R.J. Buresh *et al*.,. Soil Science of America Special Publication, Madison, W.I. USA.

Putra, I. 2016. Pengaruh kompos titonia dan jerami padi terhadap sifat kimia tanah, pertumbuhan dan hasil padi sawah(Oryza sativa, L) di Kabupaten Bener Meriah, Tesis. Program Pascasarjana Universitas Syiah Kuala, Program Studi Konservasi Sumberdaya Lahan. 40 halaman.

Sanchez, P. A and B. A. Jama. 2000. Soil Fertility Replenishment Takes of In East and Southern Africa. International Symposium on Balanched Nutrient Management System For The Moist Savanna and Humid Forest Zones of Africa. Held In October, 9 th 2000 In Benin. Africa. 32 halaman.

Sedjati, S. 2005. Kajian pemberian jerami padi dan pupuk pada kacang tanah. Skripsi. Fakultas Pertanian Universitas Muria, Kudus. 64 halaman.

Setijono, S. 1996. Inti Kesuburan Tanah. IKIP Malang, Malang-Jawa Timur 156 halaman.

Subagyo ; N. Suharta dan A. B. Siswanto. 2000. Sumberdaya Lahan Indonesia dan Pengelolaannya. Tanah-tanah Pertanian di Indonesia. Pusat Penelitian Tanah dan Agroklimat, Departemen Pertanian. Halaman 22-65.

Subhan. 2016. Pengaruh blotong dan kompos jerami padi terhadap sifat kimiatanah, serapanharasertapertumbuhantanamanjagung (zea mays L.) padaAndisol, Tesis. Program PascasarjanaUniversitasSyiah Kuala, Program StudiKonservasiSumberdayaLahan. 74 halaman.

Suwahyono, U.2015. Cara CepatBuatKomposdariLimbah.PenerbitPenebar Swadaya, Jakarta. 110 halaman.

Utomo, M., Sudarsono, Rusman, B., Sabrina. T., Lumbanraja, J., dan Wawan. 2015. Ilmu Tanah. Dasar-dasar dan Pengelolaan. Penerbit Kencana, Jakarta. 433 halaman.

Wahyono, S, L. Sahwa, Firman dan R. Suryanto. 2011. Membuat Pupuk Organik Granul Dari Aneka Limbah. Agro Media, Jakarta Selatan. 100 halaman.