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USING OF GREEN MANURE CROP AND SOIL IMPROVEMENT MATERIALS IN ACID SOIL FOR PLANTING SHALLOT IN SRISAKET PROVINCE

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ABSTRACT:

The use of green manure with the soil conditions to planting shallots was conducted at Srisaket Province. This two - years study plan was RCBD with 4 replication and 6 methods as following: 1) green manure with chicken manure (farmer method) 2) green manure alone 3) green manure with dolomite 4) green manure with rock phosphate 5) green manure with rice hull ash and 6) green manure with gypsum. The experiment results appeared that method 1) and method 5) were higher than other methods. The average yields were 1,925 and 1,700 kg per rai, respectively. These may be due to the chicken manure and green manure crop contain high nitrogen and potassium which were the essential elements for plant growth. The soil properties after experiments were changed in the positive way. Soil pH increased because organic matter content in green manure crop, rice hull ash, chicken manure, including dolomite and gypsum could increase soil pH buffering. Consequently, phosphorus and potassium were more available to shallots. Moreover, the water holding capacity increased and soil bulk density decreased which intended to be benefit to shallots.

In the economic return issue, it was found that the first method got the highest return which was 19,700 bath per rai. The method 4) got the income return at 14,920 bath per rai. Moreover, the first method got the lowest breakeven point which was 206.35 kg per rai. This mean that if farmers used chicken manure with green manure crop, they could increase yield at least 206.35 kg per rai. It was recommend that the rice hull ash should be applied green manure crop and chicken manure in order to improve soil acidity. According that rice hull ash contain 4.06% of potassium and high organic matter, rice hull ash was suitable to improve soil pH and soil structure which had the important roll to produce starch and sugar in shallots.

Keywords: Green Manure Crop, Soil Improvement Materials, Acid Soil, Planting Shallot

1. Introduction

Soil fertility in Northeast of Thailand is mostly low fertile there is a sandy and soil water retention very low. It was found that a high erosion on upland and slope area. Acid soil is almost area in Northeast, it caused by leaching a long time and accumulate oxides of Fe, Al and Mn in soil effect to soil nutrients not beneficial to plants. As a result, crop yields decrease. The present, one of causes for acidification is the continuous chemical fertilization to some nutrients residues in soil, causing the soil to become acidic. It also found that solid structure, plowing to hard work and soil nutrients is not useful to plants.

Sisaket is a region in the lower Northeast with a lot of soil acid. The most important economic crops of this province are shallots. Most of the shallots are planted in three districts, Rasi Salai, Yang Chum Noi and Kanthararam, in other districts only a few. Shallot is a vegetable that millions of baht per year in Sisaket Province. However, because it is a plant that grows and yields well in clayey loam and soil pH was 5.5-6.5 while most areas (Soil Group 17 and 35) have 4.5-5.0 of soil pH to soil is acidic so the yield of shallot is low. In order to increase the yield of shallot, it is necessary to have good soil management. The use of green manure as a soil amendment is another method applied in the area by improving soil pH to suit plant growth, improves the usefulness of plant nutrients in soil, reduces the toxicity of some plant nutrients and the soil has better physical properties. So, in this study, we have used green manure and soil amendment to improve the soil acidity in the area. In order to reduce the cost of production for farmers and to manage the soil in organic farming sustainability.

2. Materials and Methods

2.1) Materials

- green manure seed (jack bean), shallot seed
- soil sampling kits, etc.
- gypsum, rice hull ash, dolomite and rock phosphate
- chemical fertilizer and liquid organic fertilizer

- measuring tape, scale and fumigator

- plastic bag, research labels

2.2) Methods

1) Research Methodology

The experiment was in RCBD design with 4 replication using chemical fertilizer recommendation rate, green manure (jack bean) 10 kg / rai, dolomite according to lime requirement, rock phosphate 400 kg / rai, gypsum 200 kg / rai and rice hull ash 3 ton/rai. This study there are 6 methods as following:

T1 = green manure with chicken manure (farmer method)

T2 = green manure

T3 = green manure with dolomite

T4 = green manure with rock phosphate

T5 = green manure with rice hull ash

T6 = green manure with gypsum

2) Operating Procedures

2.1) Farmer area selection with 40B soil group (Phra Thong Kham: Ptk soil series) that is acidic. The area is divided into 8 x 3 m^2 plots of 24 plots, the distance between plots is 0.5 meter.

2.2) Soil was plowed several times to remove weeds and then apply dry compost from Pho.Dho 3. rate 100 kg/rai to control plant disease all experimental methods. Then sow the soil improvement material to the plot as planned after that to green manure crop planting rate 10 kg / rai and plowing, crushing into the soil.

2.3) Planted with the head of shallots, about mid-October planting distance of 20 x 20 cm 1 head / hole. Before planting, it must be watered to convert the moisture and take to the seedlings were planted in the plots to deepen the soil about half a head. Then, cover with rice straw, water every day in the morning. In the maturity stages of shallot and close to harvest may be given to each other day to stimulate the shallot is better head. Then spraying liquid organic fertilizer at 1 liter / rai (mix at 1: 200 ratio). Spraying every 10 days from age 15 days to 60 days (1 week before harvest) for all experimental methods.

2.4) Use of chemical fertilizer 13 -13 -21 recommended by soil analysis and split input 3 times. The first time, put fertilizer on and the second put fertilizer to the shallots are 15 to 20 days old. The third time when the shallot is 45-50 days old (start to head) by sowing the whole plot before the water and care until the age of 80-90 days. When it is near harvesting, the water should be kept for about 10-15 days before harvest (notice the color of the leaves must be start yellow and fallen onions). After picking the onion from the plots, we then harvest the produce to weigh. Then, bring the wind in the shade until the leaves are dry for 10-15 days and tied in a bunch of 2-3 kg. Then take to dry weight again.

3) Recording

3.1) Soil Data soil samples were collected before planting 1 time, after applying soil improvement material 1 time, after planting green manure crop 1 time and after harvesting shallot 1 time which total 4 times, each year, the same. In each subdivision, every soil sampling plot was collected in the intermediate area at a depth of 0 - 15 cm and combined it into one example of each subdivision for analyze pH, EC, OM, P, K and soil samples using core sampling for bulk density analysis.

3.2) Plant Data weighing fresh, dry weight of green manure crop and analyze nutrient content. Then measure the growth of shallots by measuring the height, fresh weight, dry weight, size and sprouting of onion. Random sampling in 2x2 square meters for 1 experiment (1x1 square meter per replication).

3.3) Economic Data collection of economic returns and analysis of costs per rai, cost per kilogram, yield per rai. yield price per kilogram, income per rai and profit per rai.

4) Data Analysis

Use statistical analysis these include: analysis of variance in RCBD, % CV (Coefficiency of Variance) and All-Pairwise Comparisons Test using LSD Method.

3. The Result

3.1) Plant Growth

1) Height

First year, the height of the shallots in each method was statistically significantly different. The experiment was using green manure with chicken manure (farmer's method) is to grow at a maximum of 39.83 cm, green manure with rice hull ash 36.53 cm, the only green manure 33.03 cm, green manures with gypsum 31.38 cm and green manure with rock phosphate 30.72 cm respectively. It was found that green manure with dolomite method gave minimum height at 29.30 cm (Table 1).

Second year, the height of the shallots in each method non-significantly different. The experiment showed that the method of using green manure with chicken manure (farmer's method), the highest growth was 41.48 cm, the application of green manure with rice hull ash 40.62 cm, green manure with rock phosphate 40.12 cm, 39.52 cm of green manure with gypsum, 38.67 cm of green manure with dolomite respectively. And found that use only green manure have the lowest height of 35.25 cm.

After the operation the results showed that the management of each soil significantly affected the growth of the shallot to use green manure with chicken manure and the method of green manure with rice hull ash increased the height of the shallot than other methods were 40.65 and 38.57 cm, respectively. Both of these methods result in the height of the shallot is non-significantly different this may be due to high nitrogen content in chicken manure and in rice hull ash have amount of potassium is relatively high. The plant nutrients are the main nutrients that are important for plant growth, so it is possible that both soil improvement materials have influence on the height of shallot rather than any other soil amendment material in the experiment.

Table 1 The mean height growth of shallot in year 1-2

Experimental Method	Height (cm)		
	Year 2010	Year 2011	Mean
Method 1 green manure with chicken manure (farmer's method)	39.83 a	41.48	40.65 a
Method 2 green manure	33.03 bc	35.25	34.14 c
Method 3 green manure with dolomite	29.30 c	38.67	33.98 c
Method 4 green manure with rock phosphate	30.72 c	40.12	35.42 bc
Method 5 green manure with rice hull ash	36.53 ab	40.62	38.57 ab
Method 6 green manure with gypsum	31.38 bc	39.52	35.45 bc
CV (%)	11.30	7.30	6.84
F - test	*	ns	**

Note: The mean, with the same letters, was not statistically different at the 95% confidence level by LSD

2) Tillering

First year, tillering of shallot each experiments method there is no statistical difference. The results showed that the maximum tillering is green manure with gypsum, 4.75 stem / clump followed by green manure with dolomite 4.51 stem / clump, green manure only 4.33 stem / clump, green manure with chicken manure (farmer's method) 4.18 stem / clump, green manure with rice hull ash 4.14 stem / clump. It was found that the lowest of green manures with rock phosphate was 3.76 stem / clump (Table 2).

Second year, tillering of shallot each experiments method there is a statistically significant difference. The results showed that the highest budding rate was the application of green manure with rock phosphate 3.80 stem / clump followed by green manure with gypsum 3.44 stem / clump, green manure 3.40 stem / clump, green manure with dolomite 3.30 stem / clump, green manure with rice hull ash 3.28 stem /clump. It was found that the lowest budding of green manure with chicken manure (farmer's method) 2.96 stem / clump.

After trial the shallots for two years found that using green manure with gypsum had the highest average tillering 4.09 stem / clump. Secondly, the application of green manure with dolomite to average budding was 3.90 stem / clump. However, considering the average of 2 years, it was found that the management of each soil did not affect the tillering of the shallots.

Table 2 The Average tillering of shallot in year 1-2

Experimental Method	Tillering (stem / clump)		
	Year 2010	Year 2011	Mean
Method 1 green manure with chicken manure (farmer's method)	4.18 ab	2.96 c	3.57
Method 2 green manure	4.33 ab	3.40 abc	3.86
Method 3 green manure with dolomite	4.51 ab	3.30 bc	3.90
Method 4 green manure with rock phosphate	3.76 b	3.80 a	3.78
Method 5 green manure with rice hull ash	4.14 ab	3.28 bc	3.71
Method 6 green manure with gypsum	4.75 a	3.44 ab	4.09
CV (%)	12.08	8.79	8.31
F - test	ns	*	ns

Note: The mean, with the same letters, was not statistically different at the 95% confidence level by LSD

3) Diameter

First year, when the shallot is applied, measure the diameter of the onions in each method. It was found that the diameter of the shallot was statistically significantly different. The experiments were carried out with the application of green manure with rice hull ash to the maximum diameter of 2.55 cm. The experiment was conducted using green manure with chicken manure 2.25 cm, green manure 2.19 cm, green manure with gypsum 2.12 cm, green manure with rock phosphate 2.08 cm. The lowest diameter of the onion was the application of green manure with dolomite to the 1.96 cm (Table 3).

In the second year, it was found that the diameter of the shallot was statistically significant difference. The highest diameter was 3.07 cm, followed by the use of green manure with rice hull ash 2.89 cm, green manure with gypsum 2.79 cm, green manure with rock phosphate 2.77 cm, green manure with dolomite 2.76 cm and only green manure application will have a minimum diameter of 2.54 cm. When it comes to the average two years. It was found that effect of soil management on onion size was significantly different. The application of green manure with rice hull ash and the method of using green manure with chicken manure (farmer's method) higher than the other methods together were 2.72 cm and 2.66 cm, respectively. Considering only two methods, it was found that the application of green manure with rice hull ash will respond to the size of the onion not difference with the method of the farmer. This may be due to the rice hull ash have a higher content of potassium than other elements, up to 4.06%, while nitrogen and phosphorus are only 1.98% and 0.23%, respectively. In addition to potassium also plays an important role in the production of starch and sugar in root crops. The rice hull ash with a high content of organic matter (7.95%), this will contribute to the improvement of the soil structure soaked and can retain a lot of moisture so the root causes the plant to grow well. For this reason, the use of rice hull ash affects the size of the onion to larger the scale, the better or the quality of the farmers.

The same way farmers as a way to use chicken manure with green manure (jack beans), it is found to contain a relatively high nitrogen content is the main nutrients that are important for plant growth.

Table 3 The Average diameter of shallot in year 1-2

Experimental Method	Diameter of Shallot (cm)		
	Year 2010	Year 2011	Mean
Method 1 green manure with chicken manure (farmer's method)	2.25 b	3.07 a	2.66 a
Method 2 green manure	2.19 b	2.54 c	2.36 b
Method 3 green manure with dolomite	1.96 c	2.76 bc	2.36 b
Method 4 green manure with rock phosphate	2.08 bc	2.77 bc	2.42 b
Method 5 green manure with rice hull ash	2.55 a	2.89 ab	2.72 a
Method 6 green manure with gypsum	2.12 bc	2.79 bc	2.45 b
CV (%)	5.5	5.98	4.22
F - test	**	*	**

Note: The mean, with the same letters, was not statistically different at the 95% confidence level by LSD

4) Number of heads per kilogram

First year, when counting the heads of shallots in each method. It was found that the number of heads per kilogram in each experiment was significantly different. The highest number of onions was 239.14 heads, followed by the use of green manure with rock phosphate was 227.46 heads, method of green manure with dolomite 208.41heads, green manure was 183.29 head, green manure with rice hull ash 151.00 head and the method lowest number of heads per kilogram was using green manure with chicken manure (method of farmers) 146.02 head (Table 4).

Table 4 The Number of heads per kilogram of shallot in year 1-2

Experimental Method	Number of Heads Per Kilogram of Shallot (head)		
	Year 2010	Year 2011	Mean
Method 1 green manure with chicken manure (farmer's method)	146.02 b	65.42	105.72 c
Method 2 green manure	183.29 ab	108.89	146.09 ab
Method 3 green manure with dolomite	208.41 ab	85.99	147.20 ab
Method 4 green manure with rock phosphate	227.46 a	87.08	157.27 a
Method 5 green manure with rice hull ash	151.00 b	84.10	117.55 bc
Method 6 green manure with gypsum	239.14 a	91.46	165.30 a
CV (%)	22.37	20.99	16.23
F - test	*	ns	*

Note: The mean, with the same letters, was not statistically different at the 95% confidence level by LSD

The number of heads per kilogram will tell the size of the head weighs 1 kg. That is, if the weight is 1 kilogram, there is a lot of onions, it means that the size of the head is small. But on the contrary, if there is a little number of head, it means that the size of the head is bigger.

Second year, from the experiment, it was found that the management of soil in each experiment was not significantly different. The only green manure method was 108.89 heads, followed by the use of green manure with gypsum method 91.46 heads, green manure with rock phosphate method 87.08 heads, green manure with dolomite 85.99 heads, green manure with rice hull ash 84.10 heads but found that method of green manure with chicken manure (the farmers method) have the lowest number of onions (65.42 heads).

After finishing the experiment for 2 year average, the management of soil in each experiment significantly differed. It was found that the application of green manure with rice hull ash and the method of green manure with chicken manure (farmer method) will give the lowest number of heads per kilogram, there were 117.55 and 105.72 heads, respectively. This shows that farmers' methods and methods of green manure with rice hull ash, although very low number of heads per kilogram. It does not mean that the management of the soil will be less responsive to growth. On the other hand, a little number of head shows the size of the larger onions, which indicates the quality of the onion itself.

However, from the further study, it is found that the number of heads per kilogram will be considered in quality classification in the commercial, say that, if the number of heads less than 65 is a very high level with a diameter greater than 3.0 cm and an average head weight of more than 15 g, while the number of head over 200 will be classified at the lower level, with a diameter of head 1.0-2.0 cms and head weight less than 5 g. (National Bureau of Agricultural Commodity and Food Standards, 2008)

5) Average head weight

From the first year experiment, the average head weight was significantly different for each method. By using green manure with chicken manure (farmer's method) will give higher weights than any other method in the experiment that is 6.90 g of head weight. The use of green manures was combined rice hull ash 6.71 g, 5.55 g of head weight for green manure method, 4.85 g of head weight for green manure with dolomite method, 4.75 g of green manure with rock phosphate method, and the lowest head weight was 4.56 g for the application of green manures with gypsum (Table 5).

Table 5 Average head weight of shallot in year 1-2

Experimental Method	Head Weight of Shallot (gram)		
	Year 2010	Year 2011	Mean
Method 1 green manure with chicken manure (farmer's method)	6.90 a	15.94	11.42 a
Method 2 green manure	5.55 bc	9.35	7.45 c
Method 3 green manure with dolomite	4.85 c	11.78	8.31 bc
Method 4 green manure with rock phosphate	4.75 c	11.75	8.25 bc
Method 5 green manure with rice hull ash	6.71 ab	12.13	9.42 b
Method 6 green manure with gypsum	4.56 c	11.89	8.22 bc
CV (%)	15.58	20.78	14.33
F - test	**	ns	**

Note: The mean, with the same letters, was not statistically different at the 95% confidence level by LSD

In the second year, it was found that the management of each method did not significantly affect the head weight. By using green manure with chicken manure (farmer s' method) average head weight was 15.94 g, followed by green manure with rice hull ash 12.13 g, 11.89 g of head weight for green manure with gypsum, 11.78 g of green manure with dolomite method, 11.75 g for green manure with rock phosphate, and only green manure have 9.35 g of head weight.

After the experiment at the two-year average, the management of soils effect to head weight was significantly different. It was found that the application of green manure with chicken manure (farmer method) and rice hull ash method was higher than that other were 11.42 and 9.42 g. Considering both methods, the average weight of the farmers method was higher than that of green manure application with the rice hull ash.

However, it can be seen that the farmers' methods and the application of green manure together with the rice hull ash affect the growth of onion better than other methods.

The use of green manure with soil improvement material for a longer period will result is better soil physical and chemical properties as a result, plants grow better and we can consider the growth or crop yield increases.

Usually weight of the head is an indicator of the quality of onion. Say that, if the weight of the head is more than 15 g considered to be very good, but if the head weight is less than 5 g, it is considered to be low. (National Bureau of Agricultural Commodity and Food Standards, 2008) When considering 2 years, it was found that the average head weight in second year 20.78 g gave higher head weight in first year 15.58 g. However, when it comes to average, the average head weight is good.

6) The yield of shallots

In the first year, yields of the shallots in each method were statistically significantly different. The experiment was conducted green manure with chicken manure method to highest yield was 1,150 kg / rai, followed by the green manure with rice hull ash method 1,100 kg / rai, 950 kg / rai of green manure method, green manure with dolomite method 880 kg / rai, which were the same as that yield with green manure with gypsum method. It was found that the green manure with rock phosphate gave the lowest yield of 760 kg / rai. (Table 6)

Table 6 Average yield of shallot in year 1-2

Experimental Method	Yield of Shallot (kg / rai)		
	Year 2010	Year 2011	Mean
Method 1 green manure with chicken manure	1,150 a	2,700.00	1,925.00
Method 2 green manure	950 abc	1,830.00	1,390.00
Method 3 green manure with dolomite	880 bc	2,220.00	1,550.00
Method 4 green manure with rock phosphate	720 c	2,540.00	1,630.00
Method 5 green manure with rice hull ash	1,100 ab	2,300.00	1,700.00
Method 6 green manure with gypsum	880 bc	2,350.00	1,615.00
CV (%)	17.88	16.47	30.11
F - test	*	ns	ns

Note: The mean, with the same letters, was not statistically different at the 95% confidence level by LSD

The second year, showed that soil management each methods to yield was not significantly different. By using green manure with chicken manure (farmer method) highest yield was 2,700 kg / rai, followed by green manure with rock phosphate 2,540 kg / rai of yield, green manure with gypsum 2,350 kg / rai of yield, green manure with rice hull ash 2,300 kg / rai and green manure with dolomite 2,220 kg / rai. It was found that the application of green manure gave the lowest yield of 1,830 kg / rai.

At the two-year average yield, it was found that soil management in each treatment was not significantly different. It was found that the application of green manure with chicken manure (farmer method) and the green manure with rice hull ash gave higher yields than other methods were 1,925 and 1,700 kg / rai, respectively. Both of these methods not significantly different when compared in the yield. This may be due to chicken manure and green manure (jack bean) are composed of high nitrogen. Rice hull ash is found to be relatively high in potassium, which is a major nutrient for plant growth. And more research, the rice hull ash obtained from the rice mill at 2,000 kg / rai, the potassium in the soil increased three times and resulted 65% increasing rice yield (Amorn and Thong On, 1992). In this experiment, the rice hull ash was 3,000 kg / rai is quite high rate so potassium in the soil will increase more than ever. It is possible that the yield of the shallot may be higher than other methods in the experiment.

3.2) Soil Properties

The soil samples were collected before and after experiments at soil depth 0-15 cm. After that analysis of soil chemical properties. (Table 7) These include: organic matter (OM), available phosphorus (P_2O_5) and exchangeable potassium (K_2O). In addition to soil physical properties. (Table 8) such as bulk density and soil moisture

1) Chemical Properties

1.1) Soil pH

The soil pH before the experiment was 4.90, which is very acidic. After experiment, the soil pH value was increased to 5.03, indicating that when soil amendments were applied

with green manure, the soil has reduced acidity. This may be due to the amount of organic matter derived from green manure, rice hull ash, chicken manure or soil amendment from dolomite, rock phosphate and gypsum, it helps to increase soil buffering capacity to adjust soil pH was higher than before the experiment.

1.2) Electrical Conductivity

Soil electrical conductivity was 0.02 dSm/m before trial. After finished the value was 0.02 dSm/m, it's mean that soil values have not changed. This may be due to post harvest, organic matter content in the area is high. It's relative in soil buffering capacity will affect soil pH to changes slowly and the absorption of various nutrients is quite low. Therefore, electrical conductivity of soil changes rarely.

1.3) Organic Matter

After trial, it was found that soil organic matter increased. Before trial, it was 0.26 % and after trial was 0.43 %. The increase in organic matter was derived from soil improvement materials such as rice hull ash, green manure, chicken manure, compost and etc. These are comprised of faster and slower decomposition. In the slow decomposition, the soil improves organic matter and better soil properties.

1.4) Available Phosphorus

Phosphorus content in soil to increase, before trial was 9.00 mg / kg. This is considered quite low may be due to soil pH. Before the experiment, the soil was acidic, so the acidity of the soil would affect the usefulness of the phosphorus in the soil, which is very acidic so that the amount of aluminum (Al^{3+}) dissolved toxic to plants. It is found in soils with a pH of less than 4.7, where by the aluminum ion reacts with the soil phosphorus to form soluble complexes or phosphorus fixation. The soil has available phosphorus is lower. But at the end of the second year, it increased to 32.50 mg / kg to be high. This may be due to the use of soil improvement materials, such as green manure, rice hull ash and chicken manures, to increase the soil's ability to reduce soil acidity. As a result, phosphorus in the soil increased more than ever.

Table 7 Change in soil chemical properties in 1-2

Experimental Method	Soil Chemical Properties									
	pH		EC (dS / m)		OM (%)		P (mg / kg)		K (mg / kg)	
	year		year		year		year		year	
	1	2	1	2	1	2	1	2	1	2
Pre - Trial	4.90	5.67	0.02	0.01	0.26	0.38	9.00	20.12	11.00	21.00
After the soil improvement material										
1) Green manure with chicken manure (farmer's method)	5.30	5.30	0.03	0.09	0.40	0.48	30.00	32.00	31.00	95.00
2) Green manure	4.80	4.90	0.08	0.06	0.44	0.41	10.00	22.00	24.00	57.00
3) Green manure with dolomite	4.80	5.20	0.05	0.05	0.32	0.37	6.00	20.00	23.00	56.00
4) Green manure with rock phosphate	4.80	6.30	0.04	0.06	0.34	0.42	15.00	22.00	21.00	65.00
5) Green manure with rice hull ash	4.70	5.60	0.04	0.04	0.29	0.38	16.00	27.00	25.00	69.00
6) Green manure with gypsum	5.00	5.30	0.04	0.06	0.56	0.48	13.00	14.00	36.00	53.00
Mean	4.90	5.43	0.05	0.06	0.39	0.42	15.00	22.83	26.67	65.83
Post - Trial										
1) Green manure with chicken manure (farmer's method)	5.80	4.8	0.02	0.02	0.40	0.50	35.50	61.00	57.00	58.00
2) Green manure	5.10	4.5	0.01	0.01	0.38	0.50	27.50	32.00	52.75	66.00
3) Green manure with dolomite	4.65	4.8	0.04	0.02	0.30	0.36	16.00	23.00	46.50	80.00
4) Green manure with rock phosphate	5.67	6.5	0.03	0.02	0.37	0.42	13.25	23.00	53.50	90.00
5) Green manure with rice hull ash	4.95	5.3	0.02	0.02	0.35	0.42	26.75	29.00	69.00	150.00
6) Green manure with gypsum	4.65	4.3	0.04	0.04	0.30	0.37	14.25	27.00	28.25	25.00
Mean	5.13	5.03	0.03	0.02	0.35	0.43	22.21	32.50	51.16	78.16

Note: Soil Analysis, Land Development Office of Region 4 (2011)

1.5) Exchangeable Potassium

After the second year was found that exchangeable potassium in soil was likely to increase as well as available phosphorus. Before the experiment, exchangeable potassium was low at 11 mg / kg. End of the experiment, it's increased to 78.16 mg / kg may be due to

the use of soil improvers such as green manure, rice hull ash, chicken manure, dolomite, gypsum and rock phosphate. These factors increase the soil pH and useful indicator of soil nutrients as a result exchangeable potassium in the soil is increased.

2) Physical Properties

2.1) Bulk Density

The bulk density of soil before experiment was lower than first experiment. The first year was 2.36 g / cm^3 and second year was 2.28 g / cm^3. After the end of the experiment, the soil physical properties are better. This may be due to soil management each method to keep water. The use of green manure, chicken manure compost or rice hull ash will help to absorb water, nutrients in the soil and bulk density to lower. More research, it was found that soil moisture content was inversely related to bulk density in soil, say that, when soil moisture increased, soil bulk density was decreased. (Pongsak et al., 2004)

Table 8 Changes in soil physical properties in year 1-2

Method	Soil Physical Properties			
	Bulk density (g / cm^3)		Soil Moisture (%)	
	Year 1	Year 2	Year 1	Year 2
Pre - Trial	2.36	2.46	7.30	15.20
Post - Trial				
1) Green manure with chicken manure (farmer's method)	1.95	2.33	11.32	5.17
2) Green manure	2.28	2.21	9.24	5.03
3) Green manure with dolomite	2.42	2.31	9.94	4.29
4) Green manure with rock phosphate	2.19	2.38	8.93	3.80
5) Green manure with rice hull ash	2.27	2.36	8.66	5.90
6) Green manure with gypsum	2.33	2.14	8.23	5.16
Mean	2.24	2.28	9.38	4.89

Note: Soil Analysis, Land Development Office of Region 4 (2011)

2.2) Soil Moisture

Soil moisture content in the first year was 7.30 % and after the second year, which was 15.20 %. The results showed that when the soil was managed by applying the green manure with various types of soil improvement materials will help to absorb moisture due to organic matter derived from the decomposition of organic substance added in to the soil. More research found that soil moisture is correlated with soil fertility, with a common reaction to plant growth and yield, as soil moisture levels affect plant nutrient uptake and the benefits of plant nutrients. However, when one factor is missing to response of plants to the rest of the factor is very small. Therefore, when the soil has two factors simultaneously, it will increase the growth of plants as well.

3.3) Economic Return

The economic returns (Table 9) on first year show that highest 4,200 baht / rai and the lowest cost 16.34 baht / kg of farmer method, followed by the use of green manure with rice hull ash method and only green manure method gave the same average 2,200 baht / rai with costs of 17.68 and 18.00 baht / kg, respectively. For green manure with gypsum, have lowest at 200 baht / rai with the cost of 19.77 baht / kg. In addition to the use of green manure with rock phosphate have a loss of 3,280 baht / rai with high cost of 24.55 baht / kg compared to the other methods.

The economic return for second year, it was found that the use of green manure with chicken manure (farmer method) was 35,200 baht / rai, followed by the use of green manure with rock phosphate and green manure with gypsum average returns were 33,120 and 29,600 baht / rai with production costs of 6.96, 6.96 and 7.40 baht / kg of shallot, respectively. And green manure only method at the lowest level of 19,800 baht / rai with production cost was 9.18 baht / kg higher than other methods. The results of the average two years, showed that the application of green manure with chicken manure, which was the farmer's method, gave the highest return of 19,700 baht / rai, followed by the use of green manure with rock phosphate 14,920 baht / rai, green manure with gypsum 14,900

baht / rai, green manure with rice hull ash 14,200 baht / rai, and green manure with dolomite 13,750 baht / rai. It was found that the application of green manure gave the lowest return 11,000 baht / rai. The production cost was 11.65, 15.75, 13.58, 13.30, 13.68 and 13.43 baht / kg respectively. Post-trial study note that in areas with strong acidity. Improving soil by using green manure (jack bean) with chicken manure will be the best method as it will gave the highest return.

Table 9 Economic returns from the use of green manures and soil improvement materials in shallots.

Method	Economic Return (baht / rai)		
	Year 1	Year 2	Mean
1) Green manure with chicken manure (farmer's method)	4,200	35,200	19,700
2) Green manure	2,200	19,800	11,000
3) Green manure with dolomite	350	27,150	13,750
4) Green manure with rock phosphate	-3,280	33,120	14,920
5) Green manure with rice hull ash	2,200	26,200	14,200
6) Green manure with gypsum	200	29,600	14,900
Mean	978.33	28,511.66	14,745

4. Conclusion and Discussion

Application of green manure with soil amendment materials for soil impronement in Sisaket Province. The data can be summarized as follows.

4.1) The use of green manure with chicken manure and method of green manure with rice hull ash was higher yield than the other, this may be due to high nitrogen and potassium content which are a major nutrient for plant growth.

4.2) Soil properties have changed. The soil has reduced acidity due to the organic matter from the green manure, rice hull ash, soil amendment material from dolomite, rock

phosphate and gypsum, will improve the buffering capacity to balance soil pH for soil nutrient content increases. In addition, it was found that the bulk density of soil decreased . As a result soil is crumbly and better soil water holding capacity.

4.3) Compared to the profitability of each method, it was found that the use of green manure with chicken manure (farmer method) average yield was 19,700 baht / rai, followed by the use of green manure with rock phosphate 14,920 baht / rai. In soils with severe acidity, soil improvement using green manure (jack bean) with chicken manure is the best method because it gives the highest yield.

5. Suggestion

5.1) In this study, should be rice hull ash applied with green manure and chicken manure (farmer method) is to improve the acidity of the soil, as the rice hull ash will have high organic matter, which will to adjust the soil pH to be suitable and help to improve the soil structure. In addition to the rice hull ash has a high potassium content of 4.06%, which is important for starch and sugarcane in root crop. It results in a good growth of shallots.

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