Techno Agriculturae Studium of Research, 1(4) - December 2024 245-255

Effects of Cattle Manure or Its Combination with Chemical Fertilizers on Growing Celery Cabbage

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Received: Nov 19, 2024	Revised: Nov 22, 2024	Accepted: Dec 25, 2024	Online: Dec 24, 2024

ABSTRACT

The experiment was conducted in Svay Rieng University in January and February 2015. The objective of the experiment was to test the effect of organic fertilizer from cattle manure alone or combination with inorganic fertilizer from urea and NPK on growing celery cabbage products. The area of each plot was 2m2 (2m length x 1m width) and spacing between each plant was 25cm and each plot was 1m. The experimental design was a Randomized Complete Block Design (RCBD) involved five treatments and four replications. The treatments were T0: Control (no fertilizer), T1: Cattle manure only, T2: Cattle manure + Urea + NPK (15:15:15), T3: Cattle manure + Liquid organic fertilizer and T4: Cattle manure + Urea + NPK + Liquid organic fertilizer. Though the experiment showed that the application of cow manure, urea and NPK fertilizer (T2) had gave plants with the greatest plant height, leaf area (length and width), root length, root weight, plant weight and biomass yield of celery. The data obtained from these treatments were significantly higher than the data obtained from the control (T0) and cattle manure alone (T1). Therefore, it is concluded that the use of organic manure from cattle manure in the production of vegetables like celery cabbage should be combination with appropriate inorganic fertilizer.

Keywords: *Cattle Manure, Celery Cabbage, Chemical Fertilizer*

Journal Homepage https://journal.ypidathu.or.id/index.php/agriculturae

How to cite: Or, C., Sin, P., Hong, C., Ros, V., Kang, T., Pen, D. & Serey, M. (2024). Effects of Cattle Manure or Its Combination with Chemical Fertilizers on Growing Celery Cabbage. *Techno Agriculturae Studium of Research*, 1(4), 245-255. https://doi.org/10.70177/agriculturae.v1i4.1512
Published by: Yayasan Pendidikan Islam Daarut Thufulah

INTRODUCTION

The fertility of soils is important in agriculture especially vegetable because it plays an important role in improving income, poverty reduction, and national and household food securities. Due to the demand for high yield of the production, farmers used imported fertilizer to grow their vegetables. Fertilizer is applied at inappropriate times and/or the wrong rates as well as overused which has an impact to the household economy and also harmed the environment.

Commercial farming and farmer have been and is still relying on the use of inorganic fertilizers for growing crops (Lampkin, 1990). This is because they are easy to use, quickly absorbed, total nutrient content, and nutrient availability, utilized by crops and yield increase. However, we believe that these fertilizers have contributed substantially to human and environmental degradation reducing the quality of arable lands and high cost in farming production, hence there is a need to look for alternatives to improve crop productivity by combining its with organic fertilizers. Organic fertilizers can therefore be used to reduce the amount of toxic compounds (such as nitrates) produced by conventional fertilizers in vegetables, hence, improving the quality of vegetables produced as well as human health. The use of organic inputs such as crop residues, manures and compost has great potentials for improving soil productivity and crop yield through improvement of the physical, chemical and microbiological properties of the soil as well as nutrient supply (Tandon, 1992; Stone and Elioff, 1998). However, the use of organic fertilizers has not been sufficiently explored to meet the production for the increase of human population. The extent to which organic fertilizers could increase the efficiency of applied inorganic fertilizers in sustaining soil and crop productivity has been received much research attention. There were some data indicate that integrated plant nutrition involving the combined use of organic and mineral fertilizers increases crop yields more than either used alone (MOFA, 1998), due mainly to the high cost of mineral fertilizers (Bumb, 1994; Gerner et al., 1995). Consequently, there is presently a serious negative balance in nutrient of soils which is a major constraint to sustainable soil management for increased crop growth and yield.

The objective of the experiment was to test the effects of cattle manure alone or combination with liquid organic fertilizers and chemical fertilizers from urea or NPK on growing celery cabbage.

RESEARCH METHODOLOGY

Location and duration

The experiment was conducted in January and February 2015 at Svay Rieng University located in National Road No 1, Chambak Village, Sangkat Chek, Svay Rieng City, Svay Rieng province.

Experimental design

The experimental design was a Randomized Complete Block Design (RCBD) involved five treatments and four replications. The treatments were:

- T0: Control (no fertilizer)
- T1: Cattle manure only

- T2: Cattle manure + Urea + NPK (15:15:15)
- T3: Cattle manure + Liquid organic fertilizer
- T4: Cattle manure + Urea + NPK + Liquid organic fertilizer

Table 1: Experiment plot layout

Plot	1	2	3	4	5
Treatment	T3	T2	T4	T0	T1
Replication	1	1	1	1	1
Plot	6	7	8	9	10
Treatment	T0	T3	T1	T4	T2
Replication	2	2	2	2	2
Plot	11	12	13	14	15
Treatment	T2	T3	T4	T1	T0
Replication	3	3	3	3	3
Plot	16	17	18	19	20
Treatment	T4	T3	T2	T0	T1
Replication	4	4	4	4	4

Germinate method and transplanting

Celery Cabbage seeds were soaked in warm water (50% of boiling water dilutes with 50% of normal water) for about 15 minutes before nursery in the tray. The good plants were selected for transplanting at 21 days. The distance between plants to plant was 25 cm.

Picture 1: seeding growing in tray (Source: Project Team)

Land preparation and spacing

The land was plowed 2 times and sun-dried before making the plots; the area of each plot was $2m^2$ (2m length x 1m width) and spacing between each plot was 1m and spacing between each plant was 25cm.

Fertilizer and applications

Dried cattle manure was collected from farmers in Svay Rieng province. It was filtered by net and applied during the plot preparation in all treatments.

Liquid organic fertilizers and Inorganic fertilizers (Urea and DAP) were purchased from fertilizers store in Svay Rieng province.

Basal fertilizers from cattle manure were applied one week before transplanting and chemical fertilizers were used for top dressing and were applied two times when the plant reach at 7 and 14 days after transplanting for treatment T2, T3 and T4 based on treatment.

The water was sprayed based on weather condition, around 2 times a day.

Table 2: Step of fertilizers application

Treatment	Cattle manure, kg/ha	Urea, kg/ha	DAP, kg/ha	Liquid organic, Liter/ha
Basal fertilizer				
T0	10000	0	0	0
T1	10000	0	0	0
T2	10000	0	0	0
T3	10000	0	0	0
T4	10000	0	0	0
Top dressing at 7 days				
T0	0	0	0	0
T1	0	0	0	0
T2	0	**65**	0	0
T3	0	0	0	**1**
T4	0	**32.5**	0	**0.5**
Top dressing at 14 days				
T0	0	0	0	0
T1	0	0	0	0
T2	0	0	**100**	0
T3	0	0	0	**1**
T4	0	0	**50**	**0.5**

Measurements

The numbers of leaves, height, length leaves, width leaves, root length, root weight and plant weight were measured at starting, 7, 14 and 21 days of ages. Five randomize vegetable per plot were representative samples to measurement. At the end of the experiment (21 days) those five representative samples were harvested including the roots in order to measure total biomass yield and root length.

Statistical analysis

The data were recorded in MS Excel and analyzed by the General Linear Model option in the Analysis of Variance (ANOVA) program of the Minitab software release 16.1.1, 2010). Sources of variation were treatments and error.

RESULT AND DISCUSSION

Growth in height

The height of celery cabbage was showed in table 3. The high of plant was not significant different when start transplanting (P>0.05) but it was significant different when the plant reach from 7 days toward (P<0.001). The highest height plant gain at the harvested was T2 (26.8cm) and then T4 (23.6cm) but the lowest was T0 which gain only 11.6 cm (figure 14, 15). However, the growth in height of the celery cabbage in this study especially in treatment T1 showed similar value with study of Chhay Ty et al 2013 when used only N from bio digester effluent at level of 10kg/ha but lesser than in T2, T3 and T4 in this study which in this study used chemical fertilizer (Urea and DAP) for top dressing. According to study of Chhay Ty et al 2015 (unpublished data) on using organic fertilizer from compost or chicken manure and combination with inorganic fertilizers from Urea and KCl with formulation to meet nutrient requirement of celery cabbage (N=120kg/ha, P2O5= 44kg/ha and K2O= 70kg/ha) showed that the high of plant was ranged from 34.5-40.2cm which ranged in this study.

Table 3: Height of Celery cabbage, cm

Ages	T0	T1	T2	T3	T4	SEM	Pro
Starting	10.07	9.83	10.345	10.045	10.17	0.343	0.874
7 days	11.9	12.3	14.9	14.0	14.2	0.662	0.017
14 days	16.4^{a}	18.2^{b}	24.1^{c}	19.4 ^{ad}	21.5^{e}	0.370	<0.001
21 days	21.7^{a}	23.1^{a}	37.2^{b}	31.9^{b}	33.8^{b}	1.596	<0.001
Gain, cm	11.6^{a}	13.2^{a}	26.8^{b}	21.9^{c}	23.6^{d}	1.444	<0.001

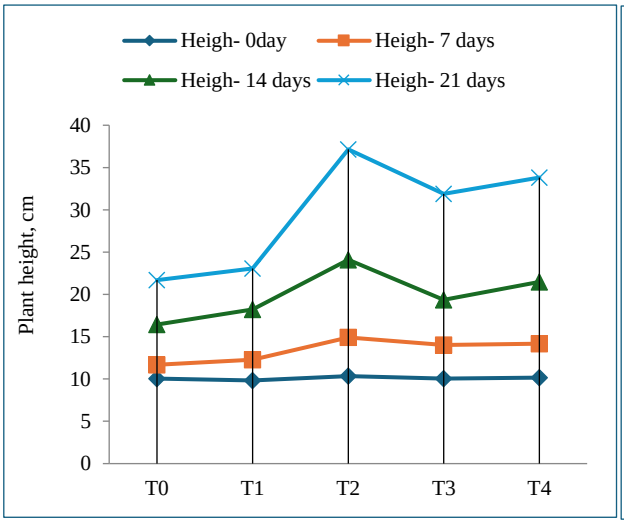

Fig. 1: Plant height of celery cabbage from cattle manure alone or combination with chemical fertilizers

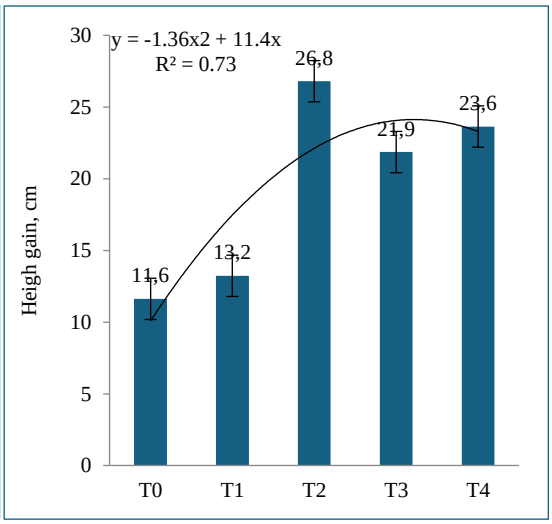

Fig. 2: Height gain of celery cabbage from cattle manure alone or combination with chemical fertilizers

Growth in leaves number

The leaves number of celery cabbage was showed in table 10. The value of leaves numbers were not significant different from starting to 14 days of plant ages (P>0.05) but it was different when the plant reach to 21 days (P=0.002). The value was not different for

T2, T3 and T4 but it was different from T0 and T1. The value of leaves number for T2, T3 and T4 was 4.20, 4.15 and 4.15 respectively and the lowest was T0 and T1 (2.15 and 3.05 respectively) (figure 16, 17). The leaves number at the end of experiment in this study was lesser than study of Chhay Ty et al 2013 which got 10.3 leaves and Chhay Ty et al 2015 (unpublished data) which got ranged from 9.55-10.04 leaves compared with this study got only 6.75 (T1 used only cattle manure) but it was closed T4 (8.00) used cattle and chemical fertilizer. The different might be different way of counting which the study of Chhay Ty et al 2013 & 2015 count every beginning of leaves appear in the plant.

Table 4: Leaves numbers of Celery Cabbage

Ages	T0	T1	T2	T3	T4	SEM	Prob
Starting	3.60	3.70	3.60	3.50	3.85	0.099	0.185
7 days	4.20	4.05	4.15	4.25	4.40	0.183	0.736
14 days	5.05	5.10	5.35	5.45	5.20	0.202	0.609
21 days	5.75[a]	6.75[a]	7.80[b]	7.65[b]	8.00[b]	0.356	0.002
Leaf gain	2.15[a]	3.05[a]	4.20[b]	4.15[b]	4.15[b]	0.387	0.006

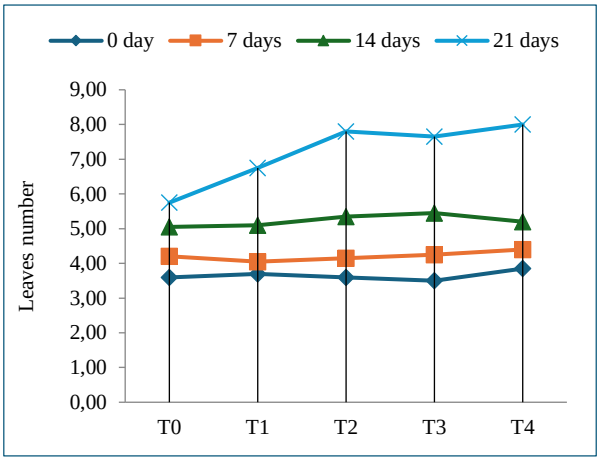

Fig. 3: The leaves number of celery cabbage from cattle manure alone or combination with chemical fertilizers

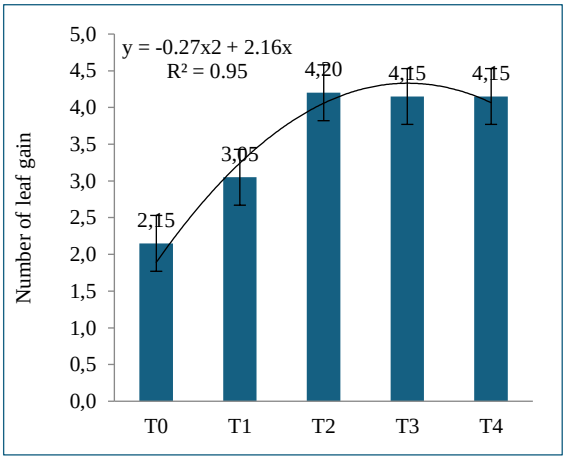

Fig. 4: The leaves number gain of celery cabbage from cattle manure alone or combination with chemical fertilizers

Growth in root length

The growth in root length was showed in table 11. The root length was not different when plant was started planting (P>0.05) but the root length was different when the plant was harvested (21 days) (P=0.026). The highest root length were appear at T2, T3 and T4 (7.88, 8.08, 7.57 respectively) and the short root length was T0 and T1 (4.23, 6.36 respectively) (figure 18, 19).

Table 5: Root length of Celery Cabbage

Treatment	T0	T1	T2	T3	T4	SEM	Prob
Starting	3.87	3.64	3.56	3.53	3.58	0.185	0.702
Finishing	8.10[a]	9.99[a]	11.4[b]	11.6[b]	11.2[b]	0.721	0.019
Root length increase, cm	4.23[a]	6.36[a]	7.88[b]	8.08[b]	7.57[b]	0.823	0.026

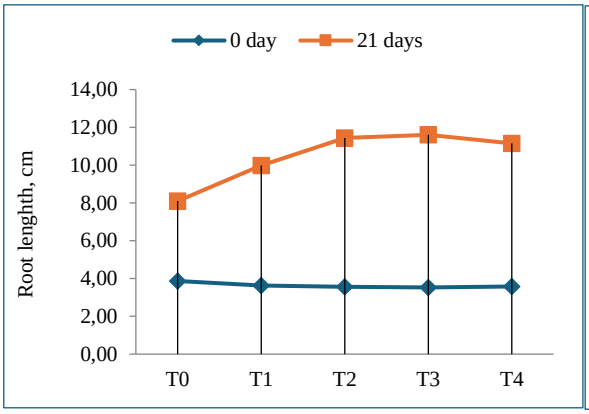

Fig. 5: Root length of celery cabbage from cattle manure alone or combination with chemical fertilizers

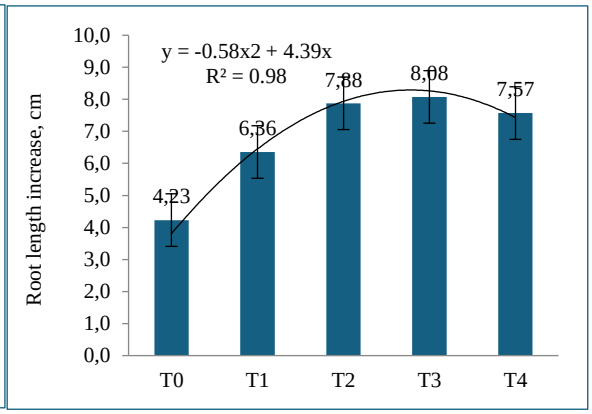

Fig. 6: Root length gain of celery cabbage from cattle manure alone or combination with chemical fertilizers

Growth in leaf length

The leaves length were not different from starting to 14 days of plant ages (P>0.05) but leaves length appear increase when the plant reach to 21 days (P=0.004). The highest leaves length was T2 (27.9cm) and then T3 & T3 (24.0, 24.5 respectively) and the short plant was T0 (14.4cm) and T1 (15.7cm) (figure 20, 21).

Table 6: Leaf length of Celery Cabbage

Treatment	T0	T1	T2	T3	T4	SEM	Prob
Starting	3.60	3.75	2.98	3.32	3.90	0.272	0.177
7 days	8.46	9.93	10.58	9.88	10.6	0.749	0.308
14 days	13.7	15.2	19.0	14.6	16.8	1.391	0.115
21 days	18.0^{a}	19.5^{a}	30.9^{b}	27.3^{ab}	28.4^{b}	2.303	0.004
Increase	14.4^{a}	15.7^{a}	27.9^{b}	24.0^{ab}	24.5^{b}	2.368	0.004

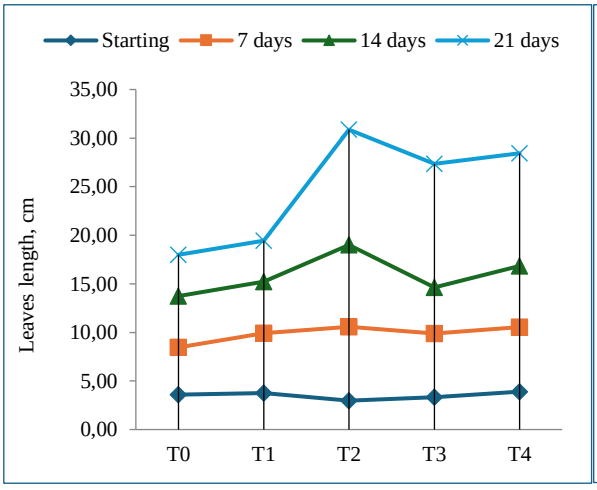

Fig. 7: Leaves length of celery cabbage from cattle manure alone or combination with chemical fertilizers

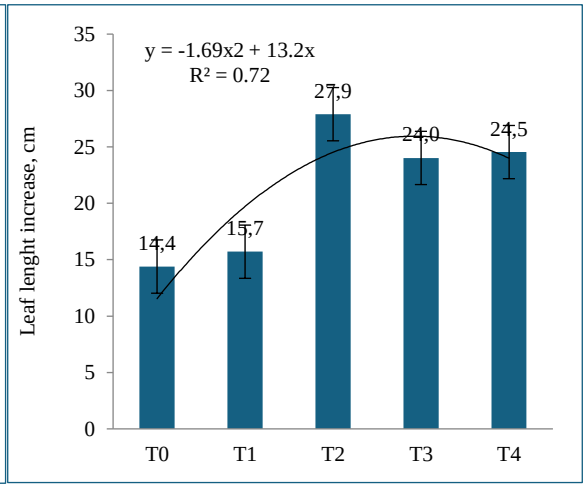

Fig. 8: Leaves length gain of celery cabbage from cattle manure alone or combination with chemical fertilizers

Growth in leaves width

The leaves width of celery cabbage were not different from starting to harvested period (P>0.05) (figure 22, 23).

Table 7: Leaf width of Celery Cabbage

Treatment	T0	T1	T2	T3	T4	SEM	Prob
Starting	2.54	2.34	2.27	2.31	2.43	0.269	0.954
7 days	3.44	3.78	3.95	3.84	4.34	0.420	0.673
14 days	5.24	5.99	7.70	6.90	6.98	0.719	0.186
21 days	7.06	10.61	12.81	11.27	11.06	1.423	0.114
Increase	4.52	8.28	10.54	8.97	8.64	1.453	0.102

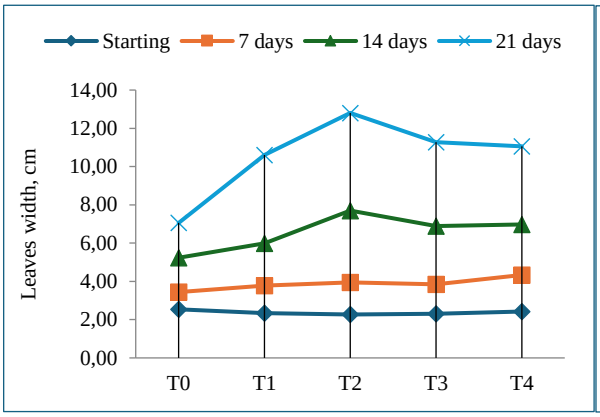

Fig. 9: Leaves width of celery cabbage from cattle manure alone or combination with chemical fertilizers

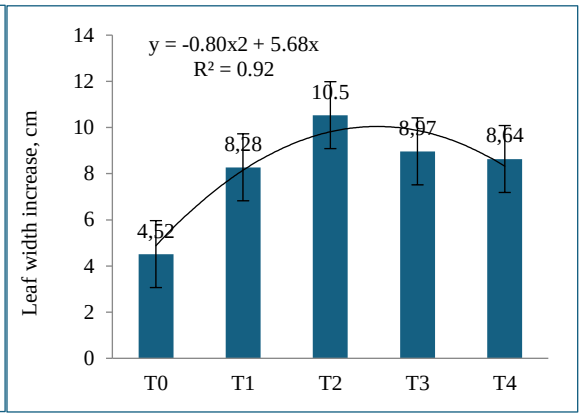

Fig. 10: Leaves width gain of celery cabbage from cattle manure alone or combination with chemical fertilizers

Biomass yield

The fresh yield of celery cabbage was showed in table 13. The weight of root was not significant different when harvested (P>0.05) but plant weight was significant different (P<0.001) among treatments but it was not different for T2, T3 and T4. However, the green biomass yield and biomass was significant different (P<0.005) and highest yield was T2 and then T3, T4 but the lowest yield was T0 and T1. The biomass yield of T1 (4.25t/ha) in this study was lower two times compared with study of Chhay Ty et al 2013 who got 8.49 t/ha, the different might be effect from bio digester effluent which charged with manure from pigs fed a commercial concentrate feed are more absorb by plant and more efficient than cattle manure during the short time. The study of Chhay Ty et al 2015 (unpublished data) on using rice husk biochar application on chicken manure or compost fertilizer on growing Celery cabbage (Brassica chinensis var) in Battambang and Takeo province, Cambodia and the study was formulation to meet nutrient requirement of celery cabbage (N=120kg/ha, P2O5= 44kg/ha and K2O= 70kg/ha) showed that the biomass yield was ranged from 25.4-26.9 t/ha compared with current study which used similar materials but the yield got only 10.8 t/ha and by the ways, the raw materials used for this study did not analyze the chemical composition and did not formulation to meet nutrient requirement of celery cabbage.

Table 8: Biomass yield of Celery Cabbage

Item	T0	T1	T2	T3	T4	SEM	*Prob*
Root/plant, g	8.95	10.575	7.925	8.5	11.05	1.582	0.587
Weigh/plant, g	18.1[a]	21.8[a]	44.7[b]	35.8[b]	35.4[b]	2.85	<0.001
Fresh yield, g/plot							
Green biomass	412.5[a]	750[b]	1941.5[c]	1100[d]	1090[d]	69.33	<0.001
Biomass	499.8[a]	885[b]	2159[c]	1299[d]	1248.7[d]	88.8	<0.001
Fresh yield, kg/ha							
Green biomass	2063	3750	9707	5500	5450	346.6	<0.001
Biomass	2499	4425	10795	6495	6244	444.2	<0.001

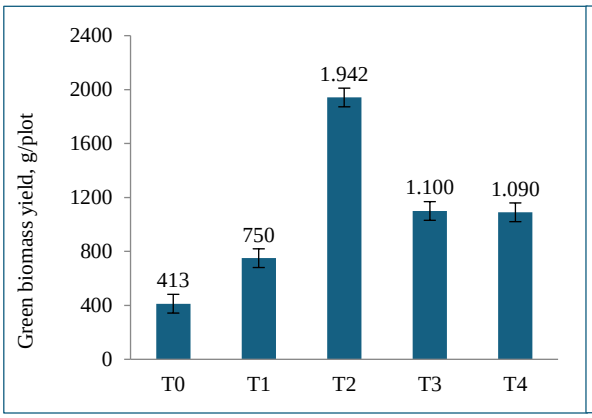

Fig. 11: Green biomass yield, g/plot of celery cabbage from cattle manure alone or combination with chemical fertilizers

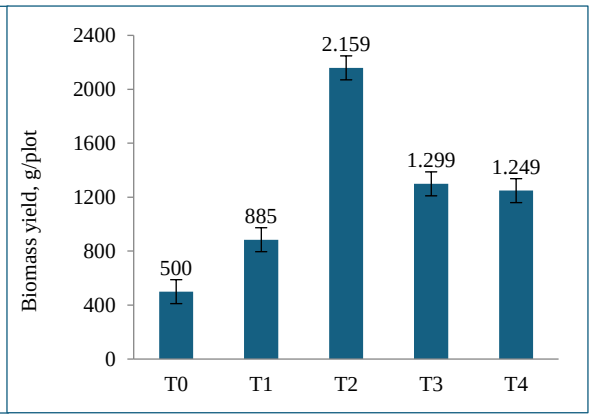

Fig. 12: Biomass yield, g/plot of celery cabbage from cattle manure alone or combination with chemical fertilizers

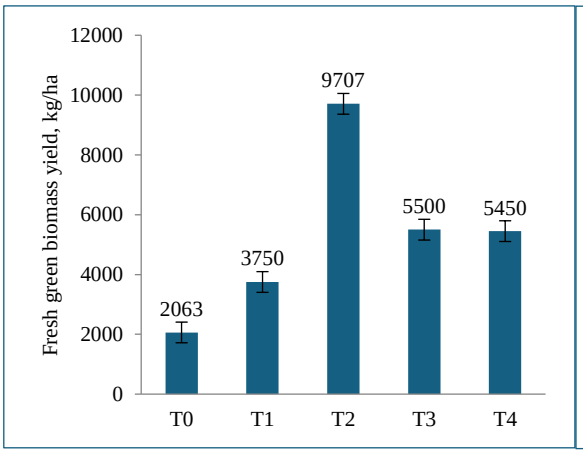

Fig. 13: Green biomass yield, kg/ha of celery cabbage from cattle manure alone or combination with chemical fertilizers

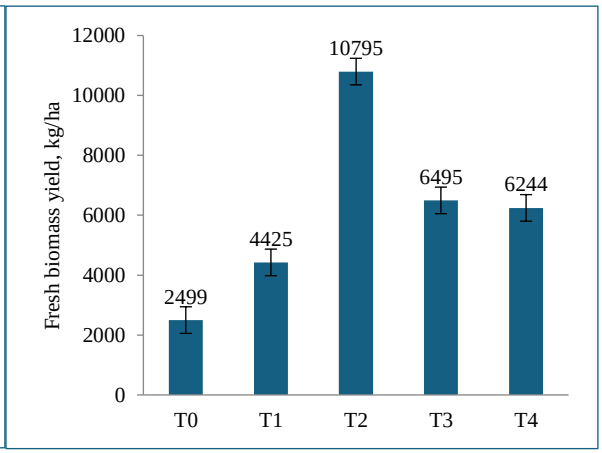

Fig. 14: Biomass yield, kg/ha of celery cabbage from cattle manure alone or combination with chemical fertilizers

CONCLUSION

Through the experiment we concluded that the yield of celery cabbage was improved when cattle manure combination with urea and NPK, however, further deep study needs to be carried out especially the chemical composition of soil before and after experiment.

Base on the result from the experiment, several recommendations are suggested as follows:

- In order to improve the production of vegetable product, chemical fertilizers are needed but if it uses in high amount or not appropriate manner will effect human health (human, animal and wildlife animal), soil quality, environment and economic impact.
- To solve these issues all research activities need to formulate the way in which to meet nutrient requirements of products and less amounts of chemical fertilizer uses.
- The research needs to improve the productivity of soil. In doing so, it especially needs laboratory facility for soil tests in order to test the chemical composition of soil, fertilizers products and as well can do with some plant analysis.

ACKNOWLEDGEMENT

On behalf of the project team, we would like to express our sincere gratitude to the Royal Government of Cambodia for providing funding support to Svay Rieng University through the Ministry of Education, Youth, and Sport. This generous support has enabled our University to successfully implement the HEQCIP project, which has involved community engagement and student-led experiments in vegetable and mushroom cultivation.

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