万田酵素を用いた自家堆肥がウコン(Curcuma spp.)およびピーマン(Capsicum annum L.)の生育と収量に及ぼす影響

Growth and yield of Turmeric (*Curcuma* spp.) and Sweet bell pepper (*Capsicum annum* L.) as inluenced by Manda-compost

Md. Amzad HOSSAIN*, Singoro MATSUURA**,
Mitsuhiro DOI** and Yukio ISHIMINE*

Key words : Farmyard manure, Manda 31 (fermented natural plant concentrate), Manda-compost, sweet bell pepper (*Capsicum annum* L.), turmeric (*Curcuma* spp.), yield.

Summary

Field and glasshouse experiments were conducted to determine efficiency of Manda-compost on growth and yield of turmeric and sweet bell pepper at the Subtropical Field Science Center, University of the Ryukyus, Okinawa, Japan from May, 2000 to February, 2001. According to the experimental design Manda-solution (100ppm or 200 ppm) or water was mixed with air-dried farmyard manure (cow manure) at the ratio of 1:5 (Manda-solution /water : Farmyard manure). The mixtures were covered with black plastic sheet for 20 days to ferment them at room temperature (25-28 C) in a glasshouse for making Manda-compost and Water-compost (normal- compost). Manda-compost or normal-compost was mixed with soil in ridge at 10 ton/ha before turmeric planting. In the study of sweet bell pepper, normal-compost was mixed with soil at the ratio of 1:11 (Normal-compost : soil) for all treatments. Manda-solution (100 ppm) or water (control) was applied directly to soil at 200 ml/pot at 15 day intervals starting seedling transplanting.

Plant length, and number of tillers and leaves of turmeric were significantly higher with the application of Manda-compost than with the normal-compost (control). Leaves of turmeric were more green, and tillers and rhizomes (yield) developed earlier in the fields where Manda-compost was applied, as compared to control plant. Significantly higher dry weight of shoot and yield were recorded in plants cultivated with Manda-compost than in control. Dry weight of shoot and yield of turmeric were similar in both the treatments applied Manda-compost.

Manda-solution (Manda 31) applied to soil also increased plant length, branches and fruits in sweet bell pepper as Manda-compost did in turmeric. Leaves were found to be more green and size of fruits was bigger in the plant grown with the Manda 31. Dry weight of shoot, root and yield were higher in the plant with the Manda 31 than in the control one.

Above results indicated that Manda-compost was more efficient than normal-compost in increasing growth and yield of turmeric. Manda 31 applied directly to the soil mixed with normal-compost also increased growth and yield of sweet bell pepper. This study suggested that Manda 31 may be used for improving efficiency of farmyard manures.

---

* Faculty of Agriculture, University of the Ryukyus, Okinawa 903-0213, Japan

** Manda Hakko Kabushiki Kaisha, Hiroshima 722-2192, Japan

Sci. Bull. Fac. Agr. Univ. Ryukyus. **49** : 205 ~ 212 (2002).

Introduction

Environmental problems caused by chemicals application in agriculture are the burning questions in the world (Erisman et al. 2001; Neera et al. 1999; Sharifuddin and Zaharah 1991). Because chemicals cause water contamination, air pollution, degradation of soil fertility, soil microorganism hazards, health hazards and food risk (Li et al. 1999; Neera et al. 1999, Swanton and Weise 1991). It is a great challenge for the agricultural scientists to produce healthy and safety food. Farmers are advised not to use chemicals and to use organic fertilizers in their fields for providing higher yield with good qualities of crops, vegetables, fruits and flowers. But it is a difficult task to increase yield and qualities of them. Manda 31 (fermented natural plant concentrate) derived from 50 plant species is one of the promising products which can improve yield and qualities of them without any hazard of environmental factors (Ishimine et al. 1999, Hossain et al. 2000 and Nakamura et al. 2001). Manda 31 contains glycine, alanine, serine, proline, valine, threonine, isoleucine, lysine, leucine, glutamine, methionine, histidine, phenylalanine, arginine, tryptophane, asparagine, cystine and tyrosine. These components somehow promote germination, growth, yield and qualities of plants.

Turmeric (*Curcuma* spp.) is a rhizomatous plant ascribed for its aromatic, stimulant and carminative properties (Hermann and martin 1991). Currently traditional Indian medicine claims the use of turmeric against biliary disorders, coryza, caugh, diabetic, wounds, hepatic disorders, rheumatism and sinusitis (Hermann and martin 1991). Curcumin and volatile oil appear to be responsible for the well documented anti-inflammatory action in the acute and subcronic models. Curcumine inhibits intestinal gas formation, lipid peroxide formation in liver and tumor formation. It also reduces cholesterol levels. Turmeric prevents cancer diseases and the production of tissue-damaging free radicals (Majeed et al. 1995). It is now widely used as spice, cosmatic and medicine in the world.

Sweet bell pepper (*Capsicum annum* L.) is one of the important vegetables of solanaceae family in the world, native to New World tropics (Tropicalfeast). Sweet bell pepper contains protein, carbohydrate, fat, vitamin-C and vitamin-A, which are very important for keeping good health (Healthnotes Inc. 2001).

Many studies have been reported that Manda 31 improved yield and quality of plants when applied to leaves and soil (Hossain et al. 2000; Ishimine et al. 1999). Cow manure increased turmeric yield significantly when mixed with soil at the ratio of 1:11 (cow manure : soil) (data not published). Cow manure fermented by Manda 31 was comparatively loose, soft and brownish (data not published). Manda 31 contains some useful microorganisms, which could help to ferment farmyard manure (Manda Hakko). It was assumed that the compost fermented by Manda 31 (Manda-compost) might be more efficient in promoting plant growth than normal-compost. Therefore, present study has been undertaken to evaluate efficiency of Manda-compost and Manda 31 on growth and yield of turmeric and sweet bell pepper.

Materials and Methods

Manda-compost preparation

Manda 31-solution of 100ppm and 200ppm were prepared by adding tap water. According

to the experimental design Manda 31-solution (100ppm or 200 ppm) or water was mixed with air-dried farmyard manure (cow manure) at the ratio of 1:5 (Manda-solution / water : Farmyard manure). The mixtures were covered with black plastic sheet for 20 days to ferment them at room temperature (25-28 C) in a glasshouse for making desired compost. The composts were named here Manda 100ppm-compost, Manda 200ppm-compost, and water-compost (normal-compost). Manda-compost (100ppm and 200ppm) was comparatively loose and soft with aromatic smell.

Studies on turmeric

Field experiment was conducted from May 5, 2000 to February 23, 2001 at the Subtropical Field Science Center, University of the Ryukyus, Japan. The soil was dark red (Shimajiri maji) with pH range of 5.7 to 6.8.

The field was laidout in a randomized complete block design. The experiment consisted of three treatments (Fig. 1) with three replications. The field was plowed and 4 m long ridges were prepared maintaining 150 cm apart. The recommended compost was mixed with soil in the ridge at 10 ton/ha before turmeric planting. Turmeric rhizome (25-30 g) was planted to 8 cm deep with 30 cm apart in two rows in each ridge. Chemical fertilizer ($N:P_2O_5:K_2O$ =1:1:2) was applied at 370 kg/ha 60, 120 and 180 days after planting (DAP). Overhead irrigation was done immediately after planting and fertilizer application.

Data on plant length, and number of tillers and leaves per plant was recorded on the September 12, 2000. The plants were harvested (February, 2001) when all leaves and shoots completely withered. Plant samples were oven dried at 85 C for 48 hours, and weighed.

Studies on sweet bell pepper

Normal farmyard manure (cow manure) was mixed with air-dried dark red soil at the rate of 1:11 (Farmyard manure : soil). Twelve kg mixed-soil was taken in each Wagner pot (0.05 m^2) and one seedling of 7-leaf stage was transplanted on the May 29, 2000. Water was applied to soil once a day for maintaining optimum moisture.

Manda 31-solution (100 ppm) was applied directly to soil in 6 pots at 200 ml/pot with the interval of 15 days starting seedling transplanting (Manda 31 treated). Water was applied to another 6 pots at the same rate (control). Chemical fertilizer ($N:P_2O_5:K_2O$ =2:1:1) was applied at 10 g/pot at 15 day intervals.

Data on plant length and number of branches were recorded at 15 day intervals starting 15 days after transplanting (DAT). Fruits were harvested five times at 7 day intervals starting 45 DAT, and number and fresh weight of fruits were recorded. Shoots and roots were measured on the August 29, 2000. Fruits (yield), shoots and roots were oven dried at 85 C for 48 hours, and weighed.

Statistical analysis

Standard deviations of the mean were included to aid in the interpretation of the growth parameters response to Manda-compost or Manda 31 (Manda-solution). Mean values of plant length, tiller, leaf, shoot and yield of turmeric were compared by using Fisher's Protected LSD test. T-test was performed to compare treatment means in sweet bell pepper.

Results and Discussion

Turmeric

Plant length, and number of tillers and leaves were significantly higher with the application of Manda-compost (Manda 100ppm-compost and Manda 200ppm-compost) than normal-compost (water-compost) (Fig. 1). Tillers of turmeric developed earlier in the fields with Manda-compost. Several studies also reported similar results in plant length, tillers and leaves in different plants treated with Manda 100ppm-solution (Hossain et al. 2000; Ishimine at al. 1999; Nakamura et al. 2001; Tsurumaki 1991). Higher plant length and tillers were the causes of higher leaves in the fields where Manda-compost was mixed with soil. Higher leaves usually receive higher solar energy which ultimately contribute to higher yield of plants. Leaves were found to be more green in the plants grown with the Manda-compost may due to the higher chlorophyll produced. The leaves contained higher chlorophyll might result in higher yield through photosynthesis. Because chlorophyll content (SPAD value) in leaf is positively correlated with the CO_2 exchange rate (CER), which indicates that photosynthetic rate increases with the increasing chlorophyll content (Sarker et al. 2002).

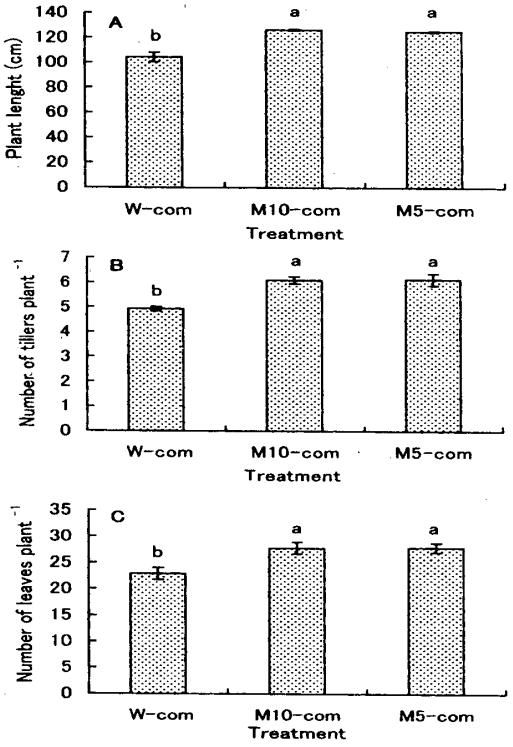

Fig. 1. Effect of Manda-compost on plant length (A), tiller (B) and leaf (C) of turmeric. W-com, M10-com and M5-com represent Water-compost (normal-compost), Manda 100ppm-compost and Manda 200ppm-compost, respectively. Bars with the same letter are not significantly different at 5% level, as determined by LSD test.

Significantly higher dry weight of shoot was recorded in the turmeric fields where Manda-composts were applied, as compared to normal-compost (Fig. 2). This result was due to the higher plant length, tillers and leaves influenced by Manda-compost. Manda 100ppm-compost and Manda 200ppm-compost showed similar efficiency on turmeric shoot production. Higher shoot of plants may result in higher yield, which agreed to the results in different studies (Hossain 1996; Hossain et al. 2000).

Turmeric rhizome developed earlier, and yield was significantly higher in the fields

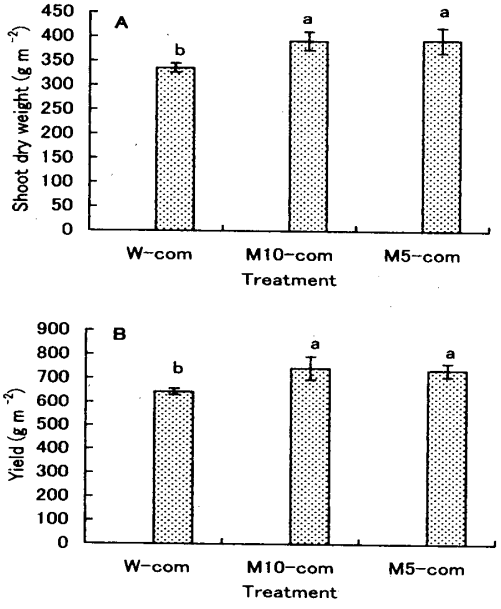

Fig. 2. Effect of Manda-compost on shoot (A) and yield (B) production of turmeric. W-com, M10-com and M5-com represent Water-compost (normal-compost), Manda 100ppm-compost and Manda 200ppm-compost, respectively. Bars with the same letter are not significantly different at 5% level, as determined by LSD test.

applied Manda-compost, as compared to control plant (Fig.2). Similar yield was observed in both the treatments of Manda-compost. This result indicated that Manda 31 improved efficiency of farmyard manure, which increased growth and yield of turmeric.

Another studies reported that Manda 31 contains different amino acids, which somehow promote germination, growth, yield and quality of crops, vegetables, fruits and flowers (Manda Hakko). It also contains some microorganisms, which may promote the process in decomposition. Soil in Manda-compost field was appeared to be more loose than in normal-compost field. Aeration can be occurred easily in loose soil, which could enhance root growth. Longer roots usually uptake higher nutrient than shorter root from soil. As a result growth and yield of plants are usually increased with the higher nutrient absorbed. Previous study also reported that Manda 31 can be absorbed by roots and it improves edaphic conditions, which supports plant to grow well (Hossain et al. 2000).

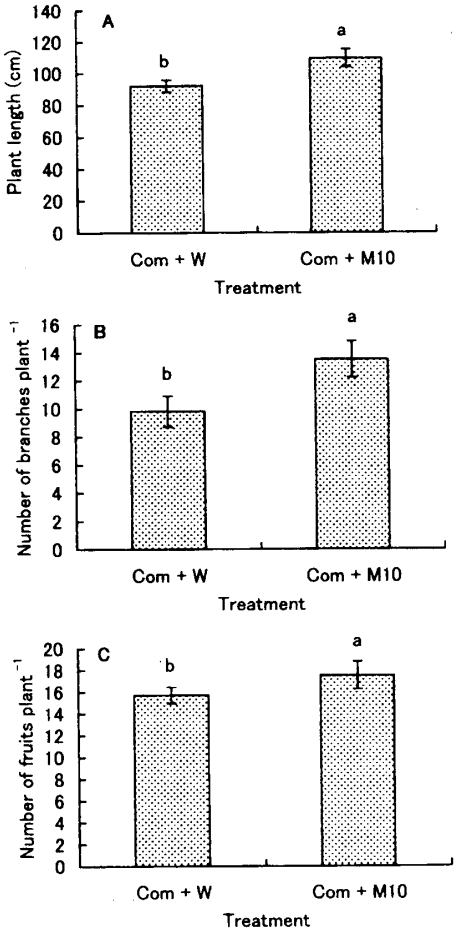

Fig. 3. Efficacy of compost with Manda 31 on plant legth length (A), branches (B) and fruits(C) of sweet bell pepper. Com + W and Com + M10 represent compost plus water and compost plus Manda 100ppm, respectively. Bars with the same letter are not significantly different at 5% level, as determined by T- test.

Sweet bell pepper

Manda 31-solution (Manda 31) applied directly to soil mixed with cow manure resulted in significantly higher shoot length, and number of branches and fruits of sweet bell pepper than water applied (Fig.3). Probably higher plant length and branches were the causes of higher number of fruits. Fruit size was comparatively bigger and leaves were found to be more green for the application of Manda 31 (data not presented). Similar result was reported in previous study where Manda 31 applied to soil or leaf (Hossain et al. 2000; Ishimine et al. 1999).

Dry weight of root and shoot were significantly higher in the plant grown with the Manda 31 (Fig.4). Soil was comparatively appeared to be loose and soft in Manda 31

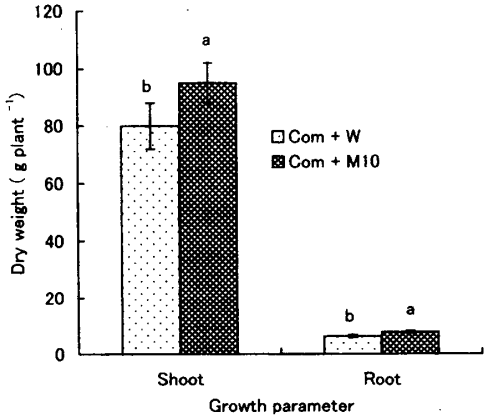

Fig. 4. Efficacy of compost with Manda 31 on shoot and root production of sweet bell pepper. Com + W and Com + M10 represent compost plus water and compost plus Manda 100ppm, respectively. Bars with the same letter are not significantly different at 5% level, as determined by T-test.

applied treatment, as observed in previous field experiment treated with Manda-compost. This soil probably maintained a good ecosystem, which directly or indirectly supported plant to grow well. Higher nutrient is absorbed when root grows well, and higher nutrient provides higher shoot. Higher shoots receive higher solar energy that ultimately result in higher yield through photosynthesis. Similarly, other studies also reported that higher yield coupled with higher root (Hossain 1996). Yield of sweet bell pepper was higher at every harvest in Manda 31 applied treatment than in control one (Fig.5). Higher number along with bigger size of fruit was the cause of higher yield in the plant cultivated with Manda 31.

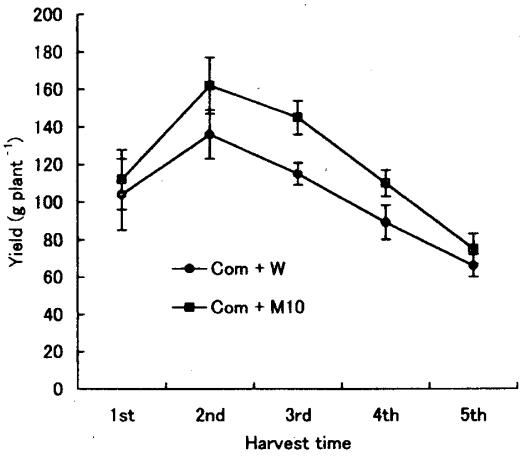

Fig. 5. Efficacy of compost with Manda 31 on yield of sweet bell pepper. Com + W and Com + M10 represent compost plus water and compost plus Manda 100ppm, respectively. Data are means ± s.d. of 6 replications.

This study concluded that plant length, and number of tillers and leaves were increased with the application of Manda-compost or Manda 31 in both the plant species tested. Leaves were found to be more green with the Manda-compost or Manda 31. Number and size of fruits were higher in sweet bell pepper grown with Manda 31 than in control plants. Significantly higher dry weight of shoot, root and yield were recorded in both the test plants where Manda-compost or Manda 31 was applied, as compared to respective control. Dry weight of shoot and yield of turmeric were similar in the treatments of Manda-compost. Above results indicated that Manda-compost was more efficient in promoting growth and yield of turmeric than normal-compost. Manda 31 improved efficiency of normal-compost mixed with soil, which resulted in higher growth and yield of sweet bell pepper. This study suggested that Manda 31 could be used with farmyard manures for improving efficiency and quality.

Source of Materials

Manda 31, a fermented natural plant concentrate was provided by Manda Hakko Kabusiki Kaisha, Innoshima, Hiroshima 722-2192, Japan.

References

1. Erisman J. W., W. D. Vries, H. Kros, O. Oenema, L. V. D. Eerden, H. V. Zeijts and S. Smeulders, 2001. An outlook for a national integrated nitrogen policy. Environmental Science & Policy, **4**: 87-95.
2. Esau B. D., G. W. Synder and A. R. Jr. Porits, 1998. Activation of ribulose-15-biphosphate carboxylase/oxygenase (rubisco) with chimeric activase proteins. Photosynthetic Research, **58**: 175-181.
3. Hermann P. T. A. and A. W. Martin, 1991. Pharmacology of *Curcuma longa*, Planta

Med. **57**: 1-7.

4. Hossain M. A., 1996. Competition between sugarcane (*Saccharum officinarum* L.) and torpedograss (*Panicum repens* L.). M. Sc. Thesis. Fac. Agr. Univ. Ryukyus, pp.1-207.
5. Hossain M. A., S. Matsuura, I. Nakamura, M. Doi and Y. Ishimine, 2000. Studies on application methods of Manda 31 for turmeric (*Curcuma* spp.) cultivation. Sci. Bull. Fac. Agr. Univ. Ryukyus, **47**: 137-144.
6. Huang D. M., G. J. Hua and Z. P. Li, 1981. The transformation and distribution of organic and inorganic fertilizer nitrogen in rice soil system. Acta pedologica Sinica, **18** (2): 120-121.
7. Ishimine Y., S. Matsuura, M. A. Hossain and I. Nakamura, 1999. Influence of fermented natural plant concentrate (Manda 31) on growth and yield of turmeric (*Curcuma* spp.). Sci. Bull. Fac. Agr. Univ. Ryukyus, **46**: 161-168.
8. Li K., J. Nakano, H. Kagata, N. Inue, M. Ohnishi, T. Inamura, T. Shirawa and T. Horie, 1999. Long term effects of chemical fertilizer and farmyard manure application on soil properties and crop production. Proc. Int. Symp. World Food Security, Tokyo, pp. 320-321.
9. Majeed M., V. Badmaev and F. Murray, 1995. Turmeric and the healing curcuminoids. Keats publishing, Inc. 27 Pine Street, New Cannan, CT 06840. pp. 1-47.
10. Mazid M. A., 1993. Sulfur and nitrogen nutration for sustainable rainfeed lowland rice. Ph. D. thesis. Fac. Grad. Sch. Univ. Philippines at Los Banos. pp. 1-232.
11. Nakamura I., S. Matsuura, M. A. Hossain, M. Doi and Y. Ishimine, 2001. Efficacy of Manda 31 with fertilizer rates on growth and yield of turmeric (*Curcuma* spp.). Sci. Bull. Fac. Agr. Univ. Ryukyus, **48**: 145-152.
12. Neera P., M. Katano and T. Hasegawa, 1999. Comparison of rice yield after various years of cultivation of natural farming. Plant Prod. Sci. **2** (1): 58-64.
13. Sarker M. A. Z., S. Murayama, H. Akamine and I. Nakamura, 2002. Effect of nitrogen fertilization on photosynthetic characters and dry matter production in F1 hybrids of rice (*Oryza sativa* L.). Plant Prod. Sci. **5**(2): 131-138.
14. Tsurumaki Y., 1991. Secret powers of Manda 31. IN Tsushinsha, Japan. pp. 1-230.

万田酵素を用いた自家堆肥がウコン（*Curcuma* spp.）およびピーマン（*Capsicum annum* L.）の生育と収量に及ぼす影響

Md. アムザド ホサイン*、松浦新吾郎**、土井 光弘**、石嶺 行男*

キーワード：自家堆肥、万田酵素混入堆肥、万田酵素（自然発酵植物凝縮物）、
ウコン（*Curcuma* spp.）、ピーマン（*Capsicum annum* L.）、収量

本実験は2000年５月から翌2001年２月にわたり、琉球大学農学部附属亜熱帯フィールド科学教育研究センターのガラス室と圃場において、万田酵素を用いた自家堆肥がウコン（*Curcuma* spp.）およびピーマン（*Capsicum annum* L.）の生育と収量に及ぼす影響を検討した。

まずウコンの試験区は万田酵素100ppm、200ppmおよび水を各々１とし、乾燥牛糞堆肥を５の割合で混ぜ合わせ、ガラス室内にて黒いプラスチックシートをかけて室温25℃から28℃で20日間保ち、熟成させたものを用いた。成熟堆肥を島尻マージの圃場に10ｔ／ｈａの割合で混入した後、うねを立て、ウコンを植えつけた。

次にピーマンの試験では１／2000ワグネルポットに、堆肥と島尻マージの土壌を１：11の割合で混合し、100ppm万田酵素溶液を200ml／pot土中に散布した処理区と水のみを200ml／pot散布した無処理区に分け移植後15日間隔で土中に散布した。

次にウコンおよびピーマンの調査の結果を示す。ウコンの草丈、分げつ数、葉数はコントロール区（万田酵素を使用しない堆肥）に比べ万田酵素を使用した堆肥混入区において有意に高い値を示した（図１）。コントロール区の植物体と比べ、万田酵素を使用した堆肥混入区ではウコンの葉はより青々とし、分げつ、根茎はともに発達が早かった。ウコンの地上部乾物重および収量においてはコントロール区に比べ、万田酵素を使用した堆肥混入区の植物が有意に高い値を示した（図２）。万田酵素を混入した両処理区においてはウコンの地上部乾物重および収量において差はなかった。

万田酵素溶液を土壌に加えたピーマンの実験においても草丈、枝数、果実はウコンの実験と同様に増大し（図３）、葉は濃く、果実も大きくなり、また、地上部乾物重および地下部乾物重は増加した（図４）。また、ピーマンの収量はコントロール区に比べ、万田溶液処理区の植物のほうが高かった（図５）。

以上の結果より万田酵素を混入し発酵させた堆肥はウコンの生長および収量の増大において大きな効果を示した。また、土壌に堆肥を混合した後、万田酵素溶液を地中に散布したピーマンの実験においても生育及び収量の増加が見られたことから、万田31号が自家堆肥の効果を改善する可能性が示唆された。

* 琉球大学農学部
**万田酵素株式会社

琉球大学農学部学術報告 **49**：205 ～ 212 (2002)