万田発酵自然植物凝縮物(万田 31 号)がウコン (Curcuma spp.) の生育及び収量に及ぼす影響

Influence of Fermented Natural Plant Concentrate (Manda 31) on Growth and Yield of Turmeric (*Curcuma* spp.)

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Key words : manda 31, turmeric (*curcuma* spp.), vegetative growth, rhizome yield.

Summary

Synthetic chemical application in agriculture causes water contamination, air pollution, degradation of soil fertility, soil microorganism hazards, health hazards and food risk. Population is increasing in the world with time while land is not increasing. It is essential to increase safty-food without any hazards of the environmental factors. Scientists are continuously trying to discover natural materials for improving crop production as well as environmental factors. Manda 31 (fermented natural plant concentrate) is a natural product from 50 plant materials which has powers to enhance yield and quality of crops, vegetables and fruits. Manda 31 was evaluated on growth and yield of turmeric at the Agricultural Experiment Farm, Faculty of Agriculture, University of the Ryukyus, Okinawa, Japan in 1998-1999. Higher plant height, tiller and leaf of turmeric were recorded in the treatments where manda 31 was applied. Manda 31 increased shoot by 9.7 to 20.2% and yield by 7 to 20% as compared with control plant. The concentration of 10,000 : 1 (water : manda 31) showed highest efficiency in increasing growth and yield of turmeric compared to higher and lower concentration. Manda 31 applied to soil also increased turmeric yield by 16%. These results demonstrated that manda 31 has powers to increase turmeric yield.

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Introduction

The missions of agricultural scientists for the 21st century are to improve yield and quality of crops, vegetables and fruits, and keep the environment suitable for health. Synthetic chemical application in agriculture causes water contamination, air pollution, degradation of soil fertility, soil microorganism hazards, health hazards and food risk. Therefore, it is suggested to reduce or cancel chemical application in agriculture (Neera et al. 1999; Swanton and Weise 1991; Worsham et al. 1995). Population is increasing in the world with time while land is not increasing. It is essential to increase food without any hazards of the environmental factors (Ohga 1999; Neera et al. 1999). Scientists are continuously trying to discover natural materials for improving crop production as well as environmental factors (Sharifuddin and Zaharah 1991; Uddin 1996). It was cited that manda 31 (fermented natural plant concentrate) has powers to enhance vegetative growth, yield and quality of many crops, vegetables and fruits (Tsurumaki 1991). Manda 31 is a highly concentrate fermented product from 50 natural plant materials such as soybean, walnut, sesame, brown rice, glutinous rice, wheat, barley, millet, marine algae, banana, apricot, orange, pineapple, apple, lotus root, sugar, honey, and others. Some high technologies are applied for more than three years in fermentation procedures to achieve its consume (final) products. It contains 0.015% ammoniacal nitrogen, 0.004% nitrate nitrogen, 0.280% water soluble organic nitrogen, 0.001% water insoluble organic nitrogen and 0.75% soluble potash (K_2).

Turmeric (*Curcuma* spp.), a member of zingiberaceae or ginger family propagates by rhizome (underground stem). It is one of the most important medical plants in the world from very beginning. It has been cited that turmeric has antioxidant properties and protective powers. Research findings indicated that turmeric prevents cancer diseases (Majeed et al 1995). Different studies reported that curcumine prevents the production of tissue-damaging free radicals. Scientists are looking for AIDS preventive properties in turmeric. It has been widely used in Bangladesh, India, Pakistan, Sri Lanka and Miyanmar (Barma) as spices, cosmetic and medicine from long before. Demand of turmeric is increasing in the world, but production per unit area is not increasing. Synthetic chemicals used in agricultural products are causes of various diseases in human body (Majeed et al. 1995). Manda 31 is a natural product which plays important roles in yield and quality improvement of crops, vegetables and fruits (Tsurumaki 1991). Therefore, present study has been undertaken to evaluate the effects of manda 31 on growth and yield of turmeric.

Materials and Methods

The experiment was conducted from May, 1998 to February, 1999 in glasshouse of the Agricultural Experiment Farm, University of the Ryukyus, Okinawa, Japan. Sun- and air-dried reddish soil (Shimajiri Maji) used in the experiments contained 0.89% C, 0.11% N, 134 mg P/100g soil; exchangeable K, Ca, Mg and Na were 0.17 , 10.8, 1.35 and 0.31 me/100g soil, respectively. Soil pH was 5.25-6.74. The experiment consisted of 5 treatments with 10 replications were as follows:

T1 (LS) :- Leaf spray at water : manda 31 = 5,000 : 1

T2 (LS):- Leaf spray at water : manda 31 = 10,000 : 1
T3 (LS):- Leaf spray at water : manda 31 = 20,000 : 1
T4 (SA):- Soil application at water : manda 31 = 20,000 : 1
T5 (Control):- with out manda 31 (water)

Each wagner pot (size 0.05 m^2, 30 cm depth) was filled with 14 kg soil. Compound fertilizer N:P:K=3.6:2.0:2.8 at 370 kg ha^{-1} was mixed with soil at planting. One turmeric (cv. *Curcuma longa*, Haru Ukon) rhizome (each 10 g) was planted 3 cm deep at the center of each pot. Water was applied two times per day to maintain adequate soil moisture. Manda 31 was mixed with water for desirable application concentration. The mixture was sprayed on both surface of plant leaves until the mixture begins to drip from leaves using hand sprayer. For the soil treatment, the mixture 20,000:1 (water : manda 31) was applied with a volume of 1000 Lha^{-1}. Manda 31 was applied one time a week at 9-10 a.m. until October starting 20 days after planting. Additional fertilizer N:P:K=3.6:2.0:2.8 at 370 kg ha^{-1} was applied at 60 and 120 days after planting.

Plant height was recorded at 15 days interval starting 20 days after planting. Number of leaves and tillers, and fresh and dry weight of turmeric-rhizomes and above-ground shoots were recorded at harvest. Plant materials were dried at 85 ℃ for 48 hours using an electric oven. Data were analyzed by Duncan's New Multiple Range test.

Results and Discussion

Turmeric plant applied with manda 31 was appeared to be better healthy and green than control plant. Plant height was promoted with the manda 31 applied than control plant (data not presented). Higher plant height may promoted higher yield of turmeric. Number of turmeric tillers was increased with manda 31 applied. Tiller was initiated earlier in the manda 31 applied plants compared to control one. Significantly higher number of tillers was recorded in the treatments where the manda 31 was applied to leaf at 10,000 : 1 ~ 20,000 : 1 (water : manda 31) concentration. However, the concentration 10,000 : 1 recorded the highest tillers among the treatments (Fig. 1). Early tillers usually provide higher yield of crop (Hossain 1999). Higher number of tillers may be effective in increasing turmeric

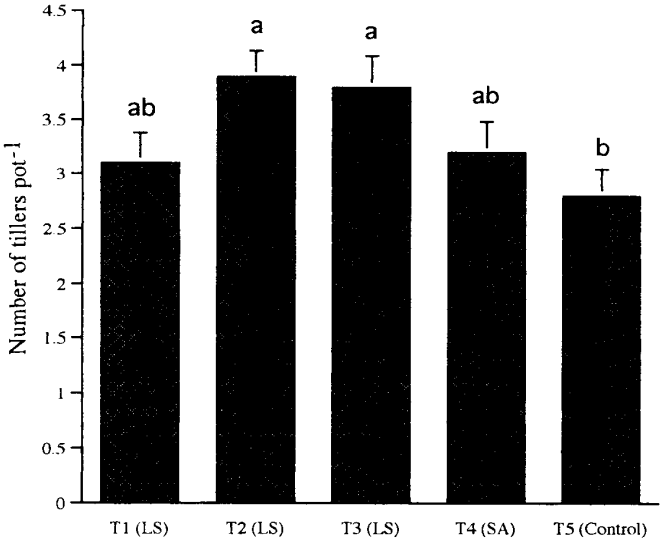

Fig. 1. Effect of manda 31 on tiller production of turmeric. T1 (LS) = leaf spray at 5,000 : 1; T2 (LS) = leaf spray at 10,000 : 1; T3 (LS) = leaf spray at 20,000 : 1; T4 (SA) = soil application at 20,000 : 1 and T5 (Control) = with out manda 31. Data are means of 10 replicates ± SE. Bars with the same letter are not different at 5% level of significance, as determined by Dancun's New Multiple Range test.

yield. Crop-yield increased with the increased number of tillers was reported by several investigators (Hossain 1999; Khan 1999 and Uddin 1996).

Manda 31 increased the total number of turmeric leaves compared to control one. Number of leaves was the highest in the treatment where the manda 31 was applied to leaves at 10,000 : 1 concentration (Fig. 2). The manda 31 applied to soil also increased the number of leaves. Higher leaves may provided higher photosynthetic activities which might be resulted in higher yield. It was reported that photosynthesis mainly occurs in leaf (Uddin 1996).

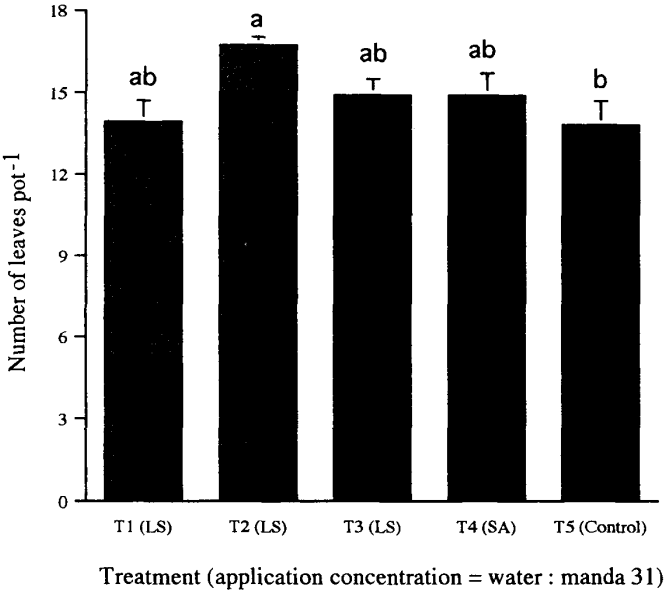

Fig. 2. Effect of manda 31 on leaf production of turmeric. T1 (LS) = leaf spray at 5,000 : 1; T2 (LS) = leaf spray at 10,000 : 1; T3 (LS) = leaf spray at 20,000 : 1; T4 (SA) = soil application at 20,000 : 1 and T5 (Control) = with out manda 31. Data are means of 10 replicates ± SE. Bars with the same letter are not different at 5% level of significance, as determined by Dancun's New Multiple Range test.

Dry weight production of shoots was significantly higher in the treatments where manda 31 was leaf-sprayed compared to control plant. Soil treated with the manda 31 also increased shoot dry weight. Manda 31 increased aboveground shoot dry weight by 9.7 to 20.2% compared to control plant (Table 1). Leaf sprayed with manda 31 at 10,000:1 (water : manda 31) resulted the highest dry weight of above-ground shoots among the treatments.

Dry weight of turmeric rhizome (yield) was increased in manda 31 applied treatments compared to control (Table 1). The yield was the highest in 10,000 : 1 applied treatment than others. Only 7% of yield was increased when the manda 31 was applied at the highest concentration (5,000 : 1). Whereas when the manda 31 was applied at 10,000 : 1 to -20,000 : 1 concentration, the yield was increased by 16 - 20% as compared with control plant. Similar trend was observed in fresh weight of turmeric rhizome (yield). Tsurumaki (1991) also reported that two-fold higher yield of different crops, vegetables and fruits obtained due to manda 31 application. Apparent translocation rate and sink ability of turmeric plant may be promoted with the manda 31 application.

Manda 31 may promoted the photosynthetic activities of turmeric may due to the K available in it. K is the major factor affecting plant biomass production due to the its effects on plant-water relationships, enzyme activity, and translocation of photosynthates (Andersson and Lundegardh 1999). K is of particular importance when plants are subject to environmental stresses such drought, heat, low temperature, and attacks by various pests and diseases. It was assumed that the manda 31 increased CO_2 exchange rate, stomatal opening activities, stomatal conductance, chlorophyll content and activities of photosynthetic enzyme (rubisco) in leaves. It was reported that higher CO_2 exchange rate increased dry weight

Table 1. Effects of manda 31 on shoot and yield of turmeric in 1998-1999 glasshouse study.

Treatment	Shoot dry weight	Yield (rhizome) Fresh weight	Yield (rhizome) Dry weight
Water : manda 31	g pot $^{-1}$		
T1(LS) = 5,000 : 1 (Leaf spray)	42.03 ± 1.55 ab (112.5)	134.1 ± 8.26 ab (104.2)	44.2 ± 2.7 ab (107.5)
T2(LS) =10,000 : 1 (Leaf spray)	44.91 ± 0.95 a (120.2)	156.3 ± 6.69 a (121.4)	49.3 ± 2.1 a (120.0)
T3(LS) = 20,000 : 1 (Leaf spray)	44.76 ± 1.13 ab (119.8)	148.7 ± 9.35 ab (115.5)	48.6 ± 2.9 ab (118.2)
T4(SA) = 20,000 : 1 (Soil application)	40.97 ± 1.72 bc (109.7)	143.2 ± 6.19 ab (111.2)	47.7 ± 2.0 ab (116.0)
T5(Control) = without manda 31	37.35 ± 0.96 c (100)	128.7 ± 5.48 b (100)	41.1 ± 1.7 b (100)

Note: Data are means of 10 replicates ± standard error (SE). Data in the parentheses indicate percentage of the control plant. Value of control plant considered 100%. Means in each column not followed by the same letter are different at 5% level of significance, as determined by Duncan's New Multiple Range test.

accumulation of rice plant (Khan 1999). Rubisco initiates both photosynthetic and photorespiratory carbonmetabolism (Esau et al. 1999). Manda 31 may promoted soil fertility and soil microbial environments which may resulted in incresed yield of turmeric. Li et al. (1999) reported that natural fertilizer improved and maintained soil fertility resulted in higher crop-yield. Soil microbial environment might be improved by manda 31 application. Uddin (1996) reported that soil microbial population was increased with the natural fertilizer application. However, we need further research on these regards, how this manda 31 increased plant dry weight accumulation and what is the mechanism of manda 31 to increase crop, vegetable and fruit yield.

From the results of the experiment it can be concluded that manda 31 increased plant height, and number of tillers and leaves of turmeric. Approximately 20% of the turmeric-yield was increased due to the leaf-spray with manda 31. The manda 31 applied to the soil

also increased yield by 16%. Leaf-spray with manda 31 at 10,000 :1 (water : manda 31) resulted the highest above-ground shoots and yield among the treatments. Manda 31 enhanced both the vegetative and the reproductive growth of turmeric. These results demonstrated that Manda 31 has amazing powers to increase turmeric yield.

Source of Materials

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

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万田発酵自然植物凝縮物(万田31号)がウコン(*Curcuma* spp.)の生育及び収量に及ぼす影響

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キーワード:万田31号(manda 31)、ウコン(*Curcuma* spp.)、栄養生長、根茎収量

農業において合成化合物の施用は、水質汚濁、大気汚染を誘発し、地力の低下、土壌微生物の減少、ひいては、人間の健康や食べ物も危険にさらす可能性がある。世界的に人口は増大しており、一方で、農業用地の増加は見られない。環境要素を危機にさらすことなく安全な食糧を増産することは重要な課題であり、科学者は、自然環境を犯す事なく作物生産を増大させる事ができる天然素材を見つけ製品化に努めて来た。万田31号(manda 31)もこのような目的で万田発酵株式会社が開発した製品である。この製品は、50種類の植物素材から造られたもので、作物、野菜、果物の収量と品質を高めることがすでに報告されている。

ここではウコンの生育および収量に対する同剤の影響を知るために1998年から1999年に、琉球大学農学部附属農場において実験を行った。方法として、5000倍、10000倍および20000倍の同剤希釈液をつくり、葉面散布処理を行なった。なお、20000倍液では土壌処理も行なった。その結果、対照区に比べて草丈が高くなり、分げつ数が増えまた葉数も増加した。乾物重を測定した結果、地上部が9.2～20.2%、根茎収量が7～20%も増加した。葉面散布処理で最も良い効果が現れたのは、10000倍希釈液であった。また、土壌処理においては、根茎収量は16%増加した。このように同剤の葉面散布および土壌処理はウコンの生育および収量の増加に大きな効果を示した。

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