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# Research and Development on Bio-products for Crop Production in China: A Short Communication

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**Abstract** The potential microorganism was isolated and screening to promote the growth for crop production in China. The isolates are screened for increasing plant growth and induce plant immunity. Bio-products are developed and tested in several kinds of plants eg. peach and citrus etc. *Chaetomium* sp. and *Bacillus* sp. were found and developed to be bioformulation for plant growth. Bio-products has developed as Bio-nutrient 1 (*Chaetomium* and *Bacillus*), Bio-nutrient 2 (liquid natural nutrient), Bio-nutrient 3 (natural substances for insect protection) and nano-kytex for plant immunity. Further research findings are still going on in progress.

**Keywords:** *Chaetomium*, Bio-products, Crop production

## Introduction

Research and development of bio-products for agriculture have conducted in China. Bio-products are applied to promote for good agricultural practice (GAP) and in combination with the application for integrated pest management (IPM) which used to decrease toxic chemicals in agricultural products and surrounding environment for sustainable development. Theses bio-products are reported as biological organic fertilizer, biological humus, liquid organic microbial fertilizers to improve soil fertility and promote plant growth, biological fungicide (Ketomium) and biologically active substances for disease control and increasing plant growth (Soytong *et al.*, 2001). There are reported that bio-organic fertilizers consists of 12 strains of biodegrader producing cellulose, amylase, protease and ligninase to increase the fermentation process and degraded organic matter. Moreover, it includes several strains of microorganism degrading rock phosphate to be available form for plants in the agricultural soil. Bio-fertilizer contain *Arthrobotrys oligospora* AO, *Aspergillus oryzae* AsO, *Aspergillus terreus* Ast, *Chaetomium lucknowens* CL, *Emericella nivea* EN, *Emericella rogulosa* ER, *Pseudoeurotium zonatum* EC, *Mucor plumbeus* MC, *Penicillium variabile* PV, *Pseudoeurotium ovale* EH, *Trichoderma hamatum* Thm-Bio1 and *Trichoderma harzianum* Thz-Bio2. It is

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high organic matter which contains a bat guano base with high nitrogen, phosphorus and potassium in organic forms, organic matter and humus, a pH of 8-9, all of which are important nutrients for plant growth including microorganisms which play the role of biodecomposer**.** **(**Phuwiwat and Soytong, 1999; Phuwiwat and Soytong **(**2001**)**; Song *et al.*, **(**2016**)**; Soytong *et al***.** **(**2001**).** Bio-humus reported to be a powder formulation and one of the best releasing biological products with a high quality of organicfood base to promote plant growth**.** It consists of*Achaetomium theilaviopsis* AT, *Aspergillus japonicus* AsP, *Gliocladium virens* GV, *Humicola fuscoatra* HF, *Mucor hiemalis* **(**MH**)**, *Paecilomyces marquandii* PM, *Trichoderma harzianum* T-01, *Trichoderma hamatum* T-02**.** It has high organic humus, humic acid, fulvic acid, amino acids and high levels of nitrogen, phosphorus and potassium in organic forms which are nutrients for plant growth including microorganism which play the role of biodecomposer and bio-stimulator for plant growth**.** The application rate is 10 g/20 liters of water spraying into soil and above plants **(**Phuwiwat and Soytong, 2001; Kaewchai *et al*. (2009).

Liquid organic bio-fertilizer is extracted from complete fermentation of fish, crab and some kind of shell which is applied as a bio-activator for rapid fermentation process of compost and directly applied into soil for plant growth It includes the screened-microorganisms as follows**:** *Actinomyces* K, *Bacillus subtilis* WC- 1, *Saccharomyces cerevisiae* RT, *Bacillus subtilis* BSP, *Bacillus subtilis* BA-1, *Bacillus subtilis* WP, *Bacillus subtilis* HB2**.** It consists of humic acid, fulvic acid, amino acid and contains the natural plant nutrition such as N, P, K, Ca, Mg, Zn, Cu, S, Fe and B**.** It has been proven to stimulate root growth and increasing plant growth**:-** root, stem, leaves and fruits and increasing quantity and quality of yield**.** Application rate is 30-50 ml/20 liters of water spraying to the soil**.** Kaewchai *et al***.** **(**2009**)** stated that some species of microorganism can be promoted several kind of plants and increase yield**.**

*Chaetomium* sp**.** is commercialized as a new broad spectrum biological fungicide or biological fertilizer in the form of pellets or powder that are formulated from mixing 22-strains of *Chaetomium cupreum* and *C. globosum***.** It is a bio-product specially formulated to provide growers with acceptable levels to control soilborne diseases, utilizing at lower rate of application and achieve improved results over other biological fungicides**.** The mechanism of disease control is competition, antibiosis/lysis, antagonism, induced immunity in plants and hyphal interference**.** It has been registered as patent rights namely**:** Chaetomium as a New Broad Spectrum Mycofungicide **:** Int**.** cl**.**5 AO 1 N 25/12 , Thailand Patent No**.** 6266**.** The formulation contains 1,500,000 colony forming units/g**.** The main key is to prevent soil-borne plant pathogens**.** It is compatible for mixing with the tested chemical pesticides (fungicides,

insecticides and herbicides**)**, which can be alternative spray with many fungicides and insecticides**.** Apply at the rate of 3-5 kg per hectare by mixing organic compost before applying to the soils at every 2-4 months for plant protection**.** The highest rate is recommended to apply in the infested field-soils**.** The powder form can be applied at the rate of 10 g/20 liters of water mixing organic or humic substances before spraying to the soil and above plants **(**Song and Soytong, 2016; Huu Phong *et al.* **(**2016**)**; Kaewchai *et al.* **(**2009**).**

Natural products from *Chaetomium* are made to be nano-particles and sucessfully tested for rice cultivation **(**Soytong *et al*; 2001; Tann and Soytong**.** 2017; Tann and Soytong, 2016**).** *Chaetomium cochliodes* reported to produce new azaphilones against some human pathogens **(**Phonkerd *et al*, 2008**).**

Research and development Laboratory, CAS Asain Agriculture, Wuxi, Jiangsu, China are conducted the microbial research finding by scientists in order to search and develop bio-products to be applied for crop production as follows**:-**

**Bio-nutrient 1 (*Chaetomium* and *Bacillus*)**

Bio-fertilizer and plant immunity agent is released to test and evaluate in the fields in China eg peach, strawberry, citrus etc**.** It consists of Chaetomium is a world unique bio-fertilizer and plant immunity agent of a mixture of effective strains of *Chaeomium* sp and *Bacillus* sp. (Fig,1).

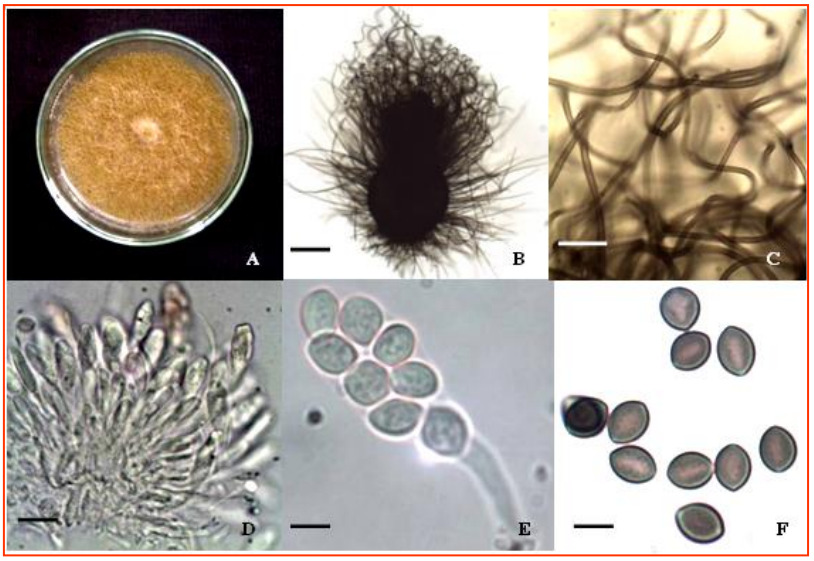


**Figure 1.** Chaetomium sp. A. 10-day-old-culture on PDA, B. ascomatum, C. ascomatal hairs, D. young asci, E. 8 ascospores in an ascus, F. ascospores. Bar. B=100µm, C,D,E,F =10µm.

It helps to increase plant growth, induced plant immunity and increase in yield. No toxic effects were observed for any living plants, animals and human. Environmentally acceptable is proved. It do not pollute and hazardous to plants, animal and human. Induction of plant resistant is reported. It can induce phytoalexin in plants to prevent pathogens and delays onset of disease incidence and delays the development of pathogen resistance. Soon after application, spores of *Chaetomium* and start to grow in organic materials in the rhizosphere soil and releasing antibiotic substances to promote plant growth and lower or delay the disease incidence. The ergosterol is also produced by the fungal biomass of *Chaetomium* leading to help for improve soil fertility and humus layer soil. Application should be used at early stage of plant growth and any developmental stages. It is compatible for mixing with any other chemical pesticides (fungicides, insecticides and herbicides), and compatible for alternative spray with many fungicides and insecticides. Application can be suggested to apply 2-3 times per year of application for perennial crops and to apply before planting for annual crops into the soils. Soil organic matter and soil pH must adjust to 6.00 to 6.50 to proper to grow better in high soil fertility with much more organic materials or compost. For Perennial Crops: Fruit Trees e.g. Apple, Peach, Sweet Orange, lime, Pamelo, Tobacco, Tea, Coffee, tobacco, grape etc, apply at 3-5 kg/hectare. For annual crops: Vegetables e.g. Kale, Chinese Cabbage, Radish, Cucumber, Chili, and potato etc. Field crops e.g. Rice, Corn, Tomato, Soybean, Water Melon, Cantaloup can be appy at the rate of 3-5 kg per hectare. Apply to plants at the rate of 20 g per 20 liters of water mixed with sticker and spreader every 15-20 days until harvest. It is similar research findings reported by Soytong *et al.* (1999); Soytong *et al*, (2001); Song *et al.* (2016); Hung, *et al*. (2015a); Hung *et al.* (2015b); Quyet *et al.* (2015); Kaewchai *et al.* (2009); Phonkerd *et al* (2008).

**Bio-nutrient 2 （Liquid Biofertilizer）**

Bio-nutrient is the naturally necessary plant nutrients to promote plant growth and increase yield. It is a mixture of naturally amino acids, humic acid, total nitrogen (N) and potassium oxide ($K_2O$). Properties are to stimulate root growth, increasing plant growth; root, stem, leaves, flowers and fruits, improving the efficacy of nutrient absorption and translocation from soil, stimulate or induce the flower buds growth in fruit trees, increasing quantity and quality of yield and improve plant stands after harvesting in fruit trees. Application rate is uased at 20-40 cc/ 15 L of water. It can mix with any chemicals or natural products. Plant recommendation are as follws: Annual crop: spray every 15-20 days e.g. rice, wheat, maize, legumes, vegetables-

pepper, tomato, cucumber, yard long bean, kale, chinese cabbage, asparagus etc., cut flowers- rose, chrysanthemum, jasmine, gerbera etc. Perennial crop: spray every 30 days e.g. banana, tea, coffee, para-rubber, citrus, lemon, long gan, linchee, rambutan, rose apple etc. This work is similar to the report of Kaewchai *et al.*, (2009), Pongnak and Soytong (2017), Vareeket and Soytong (2017).

**Bio-nutrient 3 (natural substances for insect protection)**

It is plant immunity agent for insect protection. It is naturally substances for plant immunity to insect pest Active ingredient is noted as naturally chitosan and sulfur solution and plant immunity agent for insect protection. Plant cells become stronger and protection insect destroy, and induce plant immunity. It acts without knockdown effects as synthetic chemical insecticides. The adults, larva or nymphs are usually die in the molting stage. The control mechanisms are as follows: antifeeding, inhibition the development of eggs, larvae and pupae, repellants the larvae and adult, blocking the molting of larvae and nymphs, adult female will less egg production, disruption of mating and sexual communication and deterring female from laying eggs Application rate is at 25-50 cc/ 20 L of water,then mixed with sticker and spreader and spraying to the plants at every 7-15 days intervals. Target insects are as follows:- Cotton bollworm, Corn earworm, American bollwarm, Leaf hopper, Pea pod borer, Diamond back moth, Boring caterpillar, Beet armyworm, Cutting armyworm, Aphids, Thrips, Fruitfly, Leaf rolling caterpillar, Leaf miner, Green stink bug, Leaf sucking plant louse, Citrus psyllids etc. It is similar research findings by Tangthirasunun *et al*., (2010), Quyet and Soytong (2017), Zhao *et al*., (2017).

**Bio nutrient 4 Nano- Kytex**

It is a natural biocontrol and elicitor. It is used as a plant growth stimulant, natural plant protection. The natural ability of nano- Kytex is to let the plant strong, then the plant cells become strong and stimulate root growth, inducing leaf flush come out. It is used to increases photosynthesis, promotes and enhances plant growth, response in developing roots, increases flower blooms. stimulating nutrient uptake, increases germination and sprouting, and boosts plant vigor, improve stand quality, increase yields, reduce fruit decay of vegetables. Applications of Nano- Kytex can reduce environmental stress due to drought and soil deficiencies and It elicits natural self- defense responses in plant cells to resist insects, pathogens, and soil-borne diseases when applied to

foliage or the soil**.** Application rate is at 25ml per 20 Litres of water and spray around rhizosphere soil, basal stem and above plants at every 30 days**.** With this, Tann and Soytong (2016) used to report that nano partcles loaded with *Chaetomium* extracts could contro, rice leaf spot in Cambodia**.**

These bio-products are tested in several kinds of plants to promote plant growth and expressed plant immunity to diseases and insects in the fields**.** All developed bio-products made in China are being evaluated in citrus **(**Fig 2 and 3**)** and peach **(**Fig 4 and 5**)** etc**.**

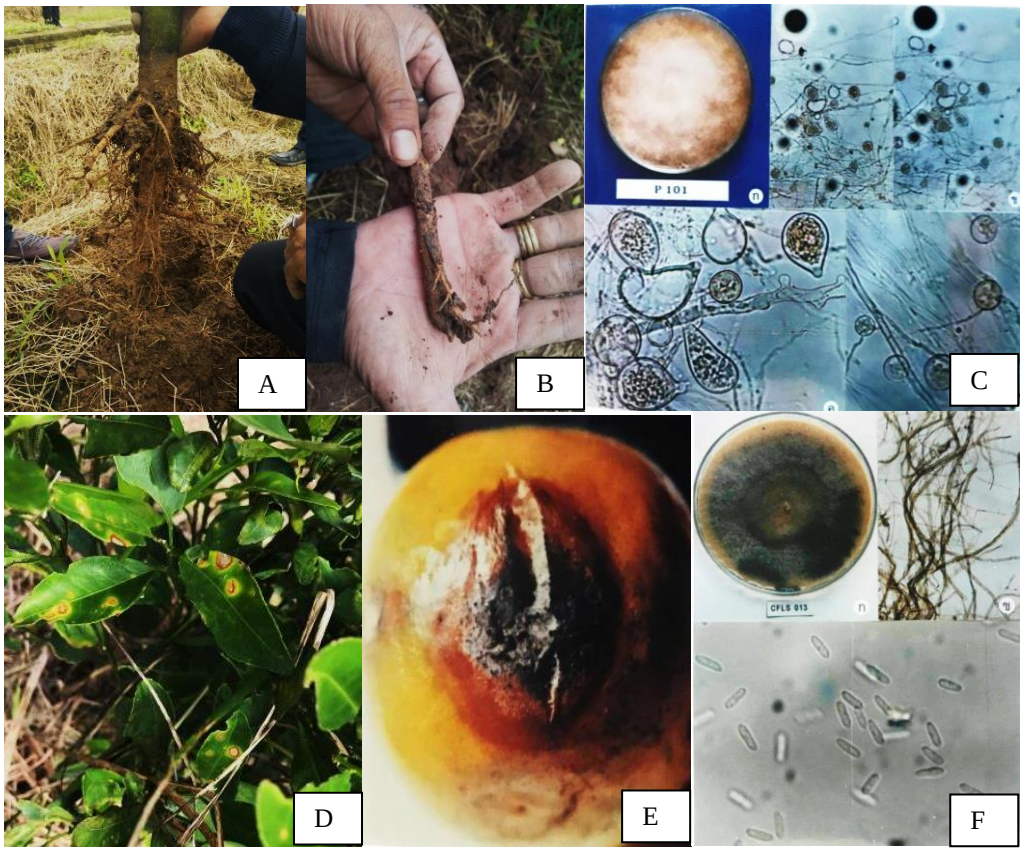


**Figure 2.** Citrus Diseases and pathogens. A,B: Citrus root rot; C: Root rot pathogen-*Phytophthora* spp.; D: Citrus anthracnose on leaves; E: Citrus anthracnose on fruit; F: Anthracnose pathogen-*Colletotrichum* spp.


**Figure 3.** Comparison of bio-products application to chemicals and non-treated control. A, D: Apply CAS bio-products (Bio-nutrient 1, 2, 3, 4); B, E: Apply Chemicals; C, F: Non-treated control.

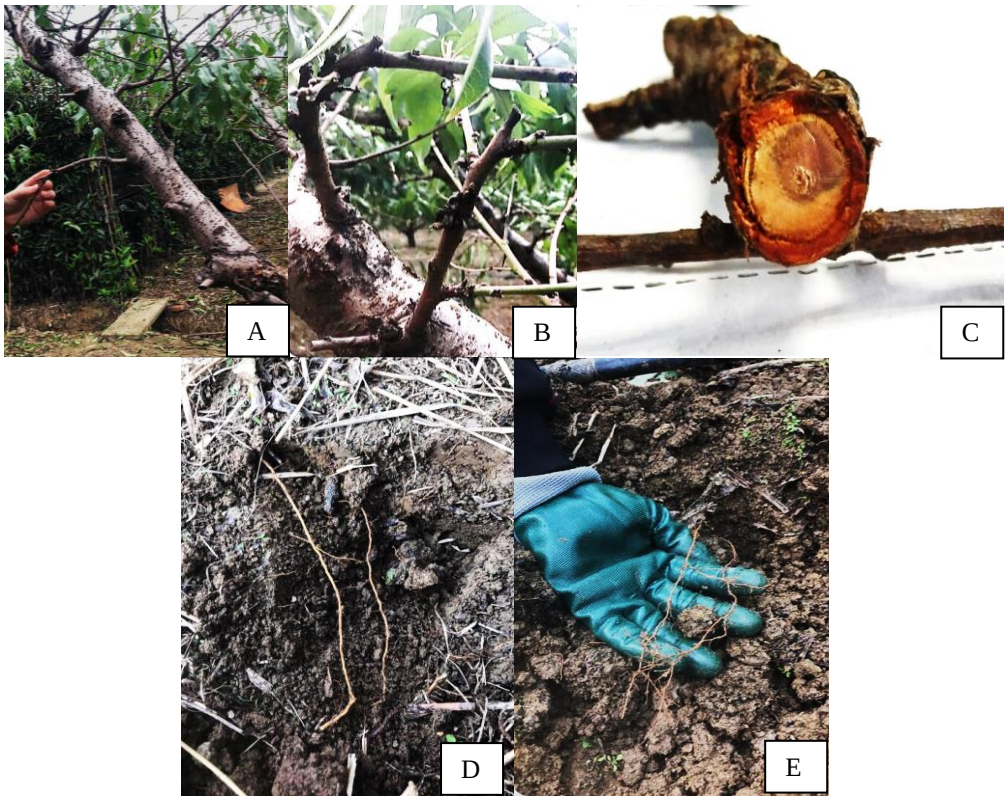


**Figure 4.** *Phytophthora* roor rot and stem canker on peach. A, B, C: stem canker; D, E: Root rot.


**Figure 5.** Application of CAS bio-products and priliminary results after application. A: Application of bio-products into rhizosphere soil; B: Application of bio-products onto plants; C: new root flush come out after 21 days application; D: stem canker stopped to invade after 21 days application.

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