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Teaching of Biopesticide Development as a Technoprenuership Opportunity in Plant Protection

Nur Amin*
Department of Plant Protection, Faculty of Agriculture, Hasanuddin University, Makassar, Sulawesi Selatan, 90245, Indonesia
* E-mail of the corresponding author : nuramin_62@yahoo.com

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Abstract
Plant protection is an important and integral part of an agricultural production system. Plant pests and diseases can cause yield losses on farm, ranging from 25 – 40% with a value of about US $550 billion worldwide. Excessive use of synthetic pesticides has caused detrimental effects on the environment and rendered agricultural production system uneconomical. Therefore, biopesticide is a promising alternative control measures in plant protection. This article discusses the teaching of technopreneurship of biopesticide with several topics of discussion, including: introduction to and the importance of biopesticide, demonstration of biopesticide development, formulation, intellectual right, and commercialization of a new biopesticide product.
Keywords: Biopesticide, Patent, Technoprenuership, Plant Protection

1. Introduction

Pests and diseases are important biological limiting factors in plant production system. Yield losses due to pests and diseases range from 25 – 40%, worth about US$ 550 billion all over the world, not including the losses in storage (Agrios, 2005). The extensive use of synthetic pesticides in 1990's was unable to provide satisfactory solution of the problems. Even some unintended detrimental effects of the pesticide use such as pest resistance against pesticides used, death of natural enemies, and agricultural product and environment contaminations have become evident.

Biopesticide is a promising alternative control ammunition in plant protection. In 2010, growers spent approximately US$ 1 billion or about 5% of the total spending on pesticides throughout the world. There is a strong tendency that biopesticide market increases while synthetic pesticide market decreases. Several factors are in favor of biopesticide use, namely: many synthetic pesticides have been withdrawn from the market because they were considered harmful to consumers and environment; global trade regulations apply low tolerance to synthetic pesticide residue in food products; farm workers are more aware of their safety in work place; and consumers' demand for healthy products increases. In addition, the implementation of the integrated pest management enhances the need for safer control measures like biopesticide (Marrone, 2008).

The growth of biopesticide market opens opportunities for an entrepreneurship in biopesticide commercialization. In order to help create new entrepreneurs, university students -especially those who are in the field of plant protection- should be taught knowledge and skills in biopesticide development. The teaching materials include the introduction and importance of biopesticide, demonstration of biopesticide development, intellectual right (patent), quality control, and commercialization.

THE IMPORTANCE OF BIOPESTICIDE

In general, a biopesticide is a pesticide with self-propogating active agent, like parasitoid, predator, and pathogen (FAO 1997). In addition, Regulation of the Ministry of Agriculture, Republic of Indonesia defines a biopesticide as a pesticide with organism, including species, subspecies, variety of insect, nematode, protozoa, fungus, bacterium, virus, micoplasma, and other organisms in all of their life stages that can be used to suppress losses due to pests and diseases in all agricultural activities, both on- and off-farms (Ministry of Agriculture, 1995)

Several microbial and biochemical pesticides that are commercially available are listed in Table 1 and Table 2, respectively.

All biopesticides listed in Table 1 and 2 were developed abroad. In general, effectiveness of a biocontrol agent is strongly affected by its environment. Locally available natural enemies are more desirable in developing a biopesticide because they are expected to be more adaptable to the environment where they are going to be used.

Therefore, in the Technopreneur class of Biopesticide Development, taught in the department of Plant Protection funded by RAMP-IPB, Hasanuddin University, students were introduced to biopesticide development using locally available organisms. In addition, they also learn about the richness of the local biodiversity, including organisms that are potential for biopesticide developments (Nur Amin *et al*, 2010).

DEMONSTRATION OF BIOPESTICIDE DEVELOPMENT

The main objective the Technoprenuer Class in Biopestisida is to demonstrate the process of a bioinsecticide development. The demonstration is carried out both in the laboratory and field with several steps starting from isolation of potential local biocontrol agents, including endophytes, entomopathogen fungi, parasitoid, and predator until the marketing of the product. From the teaching activities, several isolates of endophytic fungi have been collected from cocoa plants (Nur Amin, *et al,* 2010). Some of the isolates have been used in the study on biopesticide development against under MP3EI Research Scheme funded by the Directorate General of Higher Eduction, Ministry of Eduaction and Culture, Republic of Indonesia (La Daha *et al,* 2012). Field demonstration was conducted by visiting local liquid fertilizer companies to stimulate students' interest in starting their own businesses in biopesticide production.

FORMULATION

One of the main factors that are potential to affect economic feasibility of a biopesticide product is formulation technology. Appropriate formulation can increase product stability and viability that can reduce inconsistency of the product in the field. One of the main constrains that commonly found in developing a new biopesticide is inconsistent performance of the product in the field. Research conducted to find appropriate formulation for a given biopesticide usually requires a lot of time (Retchelderfer,1984; Greaves, 1993). Technical and chemical compatibility and application method are prerequisite for the success of a new biopesticide product in the agricultural industry. Good formulation can be reflected by the long product storability.

Several commonly used biopesticide formulations include granules, pellets, dry powder, and wet powder. Granules can protect the active agent from desiccation and also provide basic food for the agent. Powder is easy to apply by suspending it in water and also can cover a wide area of application. Powder formulation is also suitable for seed treatment (Urquhart & Punja, 1997; Nur Amin, 2011a, b).

INTELECTUAL PROPERTY RIGHT (PATENT)

The objective this teaching material is to give an understanding to the students about the importance of the intellectual right in the research, development, and innovation in university. This material describes in details the steps of applying for an intellectual right, specifically for a biopesticide product, namely: 1) invention title, 2) technical field of the invention, 3) invention background, 4) brief description of the invention, 5) brief explanation of the pictures, 6) claims, 8) abstract, and 9) pictures (if applicable) with physical description of the invention. Students are also directed to perform literature search on the web to gather information about patent application. Some of the webs students can visit are: www.uspto.qov (US), www.jpo-miti.go (Japan), www.ipaustralia.qov.au (Australia), www.patens1.ic.qc.ca/intro-e.htl (Canada), www.european-paten-office.org/espacenet /info/index (Europe), www.delphion.com (general information). At the present time, we have applied for several patents for biopesticides that have been developed in our laboratory. (Nur Amin et al, 2011 a, b dan Nur Amin, 2012).

COMMERCIALIZATION (ENTREPRENEURSHIP)

In this session of teaching activities, students are taught and showed how to make a business plan for biopesticide business. After having comprehensive and thorough understanding of the material, they are asked to complete individual assignment of making a business plan. Their business plans are then discussed in the class through student presentations in front the class. Our experiences show that this class assignments effectively help students to grasp the important ideas and processes in developing a new biopesticide and its commercialization.

IMPORTANT NOTES

The subject of "Biopesticide Development as an Entrepreneurship Opportunity" has been offered and taught for the last three years at the Department of Plant Pests and Diseases. From this experience, several important points are worth noted as follow:

1. The subject of Technoprenuer should be offered as inter-university class taught by teaching staffs from different universities involved. The teaching staffs should have experience in technopreneur in

different fields of business. Therefore, the teaching topics can be rotate from year to year. The teaching delivery can be done in the form of video conference. For agricultural industry, one of the teaching topics could be biopesticide technopreneur

2. Full support of the university management is needed in order to create an effective technopreneur education. For example, Hasanuddin University has a **"Teaching Industry Building"**, equipped with facilities necessary for innovation and invention of new product. A section of the facilities are specifically used for developing biopesticide and biopfertilizer. This is an important step towards the goal of making Hasanuddin University as an "Entrepreneur University"

REFERENCES

Agrios, G.N. (2005). Plant Pathology. Fifth Edition. Elsevier Academic Press. Amsterdam, Boston, Heidelberg, London , New York , Oxford, Paris, San Diego, San Francisco, Singapore, Sydney, Tokyo

FAO. (1997). Code of conduct for the import and release of exotic biological control agents.

Biocontrol News and Information **18** (4): 119N−124N.

Greaves, M.P. (1993) Formulatron of mircrobial herbicides to Improve performance in the field, in *Proceedings of 8th EWRS Symposium "Quantitative Approaches in Weed and Herbicide Research and Their Practical Application, "* Braunschweig, Germany, pp. 219-225.

Ministry of Indonesian Agriculture. (1995). Regulation of the Ministry of Agriculture Number 41I/Kpts/TP.120/6/1995 on Biological Agent Importation into the territory of the Republic of Indonesia. *Ministry of Agriculture*, Jakarta (In Indonesian Language).

La Daha, Nur Amin & Nurariaty, A. (2012). Endophytic Fungi in Form of Capsul to Control of Cocoa Pod Borer Conophomorpa cramerella on Cocoa Plant. Final Report of National Research Priority in Masterplan of acseleration and Extention of Indonesian Economic Development 2011-2025.

Marrone, P.G.. (2008). Integrated Pest Management (Concept, Tactics, Strategies and Case Studies). Cambridge University Press.

Nur Amin; Nurariaty, A;Melina & Nasruddin, A. (2010). Development of Biological Agents. Final Report Enterprenuership Course Development. RAMP IPB - Department of Plant Pests and Diseases.

Nur Amin, La Daha & Nasruddin, A. (2011a). Endophytic fungi in Pellet Form For Leaf Borer *Oryctes rhinoceros* and *Sexava* sp. On Palm Oil Plant. *Patent Number 00201100017* (In Indonesian Language).

Nur Amin, La Daha & Nasruddin, A. (2011b). Fungal endophyte as Biopesticide and Biofertilizer in Form of Tablet. *Patent No. 00201100098* (In Indonesian Language).

Nur Amin. (2012). Compost Extract from Organic Waste In Pellet Form for the control of black pod diseases of Cocoa *Phytophthora palmivora.* Patent Number 00201200440 (In Indonesian Language).

Retchelderfer, K (1984) Factors affecting the economic feasibility of the blologtcal control of weeds, *Proceedings of VI International Symposium on Biological Control of Weeds* (Delfosse, E. S , ed), *Agr Can Bull* , pp. 135-144

Urquhart, E. J & PunJa, Z. K. (1997) Epiphytic growth and survival of *Tilletiopsu pallescens*, a potential biologlcal control agent of *Sphaerotheca jilznea*, on cucumber leaves. *Canadian Journal Botani.* **75,** 892-90 1.

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Table 1. Commercially available microbial biopesticides for plant pathogen control

Microorganism	Trade Name	Disease/pathogen Target	Plant Host
Pseudomonas syringae ESC 10	Bio-Save® 10LP3	Soft rot (*Rhizopus* sp.)	Potato
Bacillus pumilus QST 2808	Ballad® Plus Biofungicide	Rust, powdery mildew, brown spot	Soybean
Bacillus subtilis GB03	Kodiak® Biological Fungicide	*Rhizoctonia, Fusarium, Alternaria, Aspergillus*	Cotton, peanut, soybean
Trichoderma harzianum Rifai strain KRL-AG2	PlantShield® HC Biological Foliar and Root Fungicide	*Fusarium, Pythium,* and *Rhizoctonia*	Bean, tomato, soybean
Bacillus subtilis QST 708	Rhapsody®	Bakterial and fungal disease, anthracnose	Grasses
Trichoderma virens (formerly *Gliocladium virens*)	SoilGard 12G3	*Pythium, Rhizoctonia,* and root rots	Ornamental and food crops in Greenhouse
Trichoderma harzianum Rifai strain KRL-AG2	T-22™ HC	*Fusarium, Pythium,* and *Rhizoctonia*	Vegetables and beans
Bacillus pumilus GB34	Yield Shield® Concentrate Biological Fungicide	*Rhizoctonia* and *Fusarium*	Soybean

Table 2. Chemical biopesticide for plant pathogen control

Trade Name	Active Ingredient	Manufacturer	Disease Target	Plant Host
Garlic Barrier®	Garlic oil	Garlic Research Labs, Inc.	Brown spots and insects	Vegetables, ornamentals, peanut, cucumber, sugar cain, sun flower
Green Light® Neem Concentrate	Neem oil	Green Light Company	Powdery mildew, rust, anthracnose, and leaf spots	Vegetables, fruits, and beans
Trilogy®	Neem oil	Certis USA	*Alternaria, anthracnose*, leaf spots, *Botrytis* powdery mildew, and rust	Fruit crops, cucumber, vegetables, beans, and cotton
Actino Iron®	Iron	Natural Industries, Inc.	Soil-borne diseases, damping-off	Fiber crops, ornamentals, forest crops
ECO E-RASE®	Jojoba oil	IJO Products, LLC	Powdery mildew and whitefly	Ornamentals and vegetables
SeaCide®	Fish oil	Omega Protein Inc.	Black spot, powdery mildew, and greasy spot	Orchids, greenhouse plants
Heads Up® Plant Protectant	Extract of *Chenopo-dium quinoa saponins*	Heads Up Plant Protectants	Soil-borne diseases, damping-off	Soybean, potato, tomato, beans, and wheat
Proud 3™	Thyme oil	Bio Huma Netus, Inc.	Fungal diseases	Ornamental crops