THE PRODUCTION AND APPLICATION OF BIOFERTILIZERS IN VIETNAM

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Abstract

This paper analyzes the production and application of biofertilizers in Vietnam. The main groups of microbial fertilizers in Vietnam are: (1) Microbial fertilizers for N fixation; (2) Microbial fertilizers for soluble phosphate;(3) Mixed microbial fertilizers for N fixation and soluble phosphate; (4) Microbial fertilizers for organic matter decomposition; (5) Vesicular-arbuscular mycorrhizal fungi (VAM). These biofertilizers are used by farmers in their fields and give effective results for improving crop yields and quality. They play an important role in the development of agriculture in Vietnam.

Introduction

Formerly Vietnam was one of the world's poorer countries. Currently Vietnam produces enough food for domestic consumption and has become a food exporter to the tune of about 3-4 million tonnes per year. Vietnam also exports coffee, rubber, tea, fruit and vegetables. Fertilizer application is an important factor for agricultural development, especially for increasing crop production.

From 1995 to 2000, the amount of fertilizers used per year in Vietnam increased — 7% (N), 8% (P) and 10% (K) (Table 1). Current industrial production of fertilizers is insufficient for agricultural development needs. Production meets 80% for P, 10% for N but almost all K fertilizer is imported (Table 2). Organic fertilizers could be used nationwide, but presently they satisfy about 25% of the requirement only.

There are about 1,420 varieties of fertilizer in Vietnam, including 20 types of microbial fertilizers and 79 types of organic matter (Table 3). Vietnam has to import about 2-3 millions tonnes of different kinds of mineral fertilizers per year, valued at US$500 million *per annum* (Table 4).

To alleviate this situation, since 1980, the government has attempted to enhance the manufacture and production of mineral fertilizers in-country and to encourage investment and cooperation in research and development (R&D) for biotechnology, including biofertilizer production.

Table 1. Fertilizer use in Vietnam (tonnes)

Fertilizer	Years				
	1981	1985	1990	1995	2000
Nitrogen (urea)	175,700	267,000	358,800	506,000	690,000
Phosphorus	38,400	49,000	82,600	185,000	260,000
Calcium	22,000	22,100	27,800	31,600	166,000

Source: Bui Huy Hien (1999).

Keywords: biofertilizers, microbial fertilizers, soluble phosphate, mixed microbial fertilizers

Table 2. Production of mineral fertilizers in Vietnam

Fertilizer	Quantity(1,000 tonnes)/year			
	1990	1995	2000	1-10/2001
Urea	24	111	50	81
Phosphorus	326	799	1,000	80
NPK	0	179	1,200	667

Source: Nguyen Van Bo (2001).

Table 3. Kind and quantity of registered fertilizers used in Vietnam

Fertilizers	Quantity (tonnes)
Mix of NPK	722
Mix of NPK + microelements	362
Mineral organic matter	79
Single fertilizers (N/P)	17
Microbial fertilizers	20
Other fertilizers	220
	1,420

Source : Nguyen Van Bo (2001).

Table 4. Fertilizer imports 1997-1999

1997		1998		1999	
Quantity (tonnes)	Cost US dollar	Quantity (tonnes)	Cost US dollar	Quantity (tonnes)	Cost US dollar
2,458	424,946	3,454	474,679	2,720	400,000

Source: Tu Kien (2000).

Main research results on biofertilizer in Vietnam

From 1980 to date, the government has invested in a National Biotechnological Programme for Research and Development on Biofertilizers. This programme involves more than ten research institutes and universities with about 100 researchers, including the NISF (National Institute for Soils and Fertilizers).

Figure 1 shows the sequence for isolating and selecting strains of micro-organisms for research on suitability for biofertilizer production.

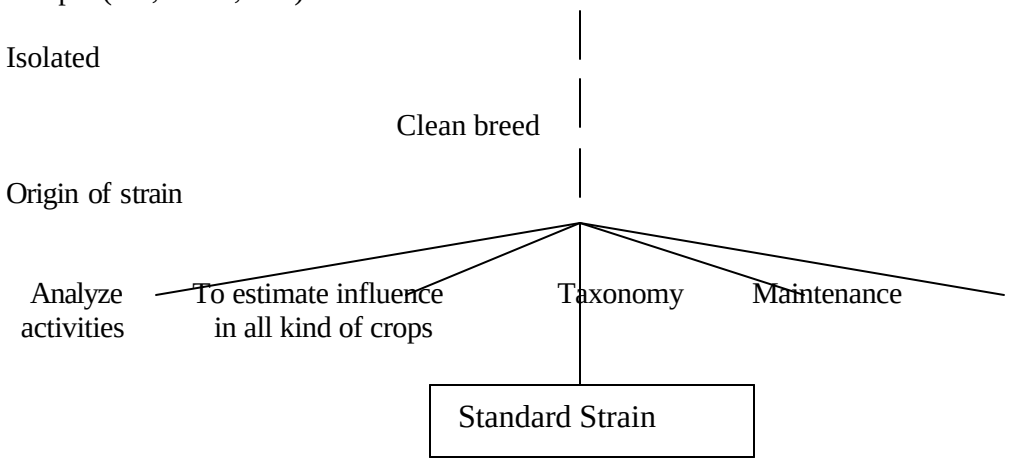

Figure 1. Sequence for isolating and selecting strains of micro-organisms

At the moment technological production of microbial fertilizer in Vietnam has been researched and perfected for every crop and for some crop groups (Figure 2). Microbial preparations can be used as a type of general fertilizer or mixed with organic matter to create microbial organic fertilizer.

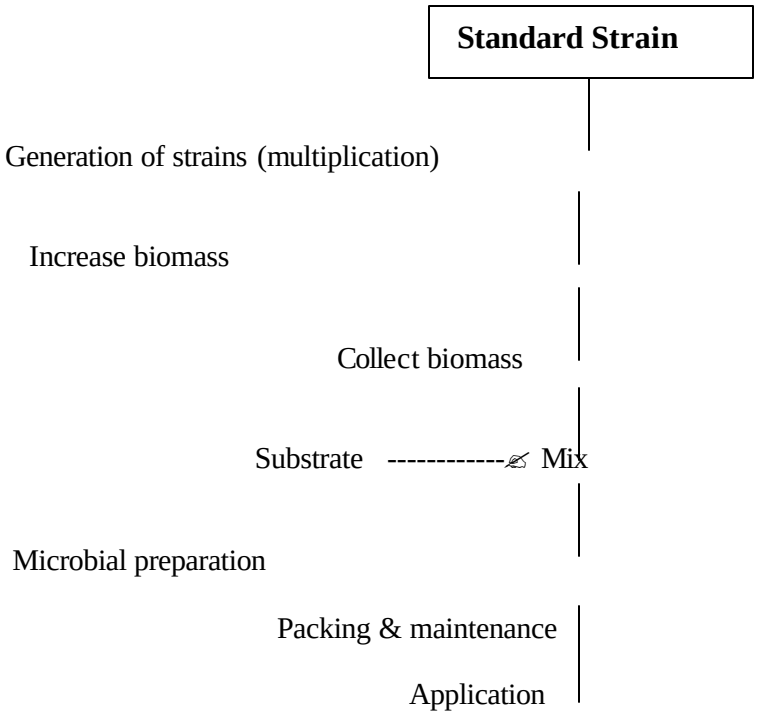

Figure 2. Production sequence for microbial fertilizers

Biofertilizer application and increasing crop yields in Vietnam

Main microbial fertilizers

Currently Vietnam has five main groups of microbial fertilizers. They have been researched, produced and used for agricultural development.

1. Microbial fertilizers for N fixation

- ✍ Microbial fertilizers for symbiotic N fixation in legumes
- ✍ Microbial fertilizers for free (association) N fixation in rice, maize, winter crops

2. Microbial fertilizers for soluble phosphate

3. Mixed microbial fertilizers for N fixation and soluble phosphate

4. Microbial fertilizers for organic matter decomposition

5. Utilization of vesicular arbuscular mycorrhizal fungi (VAM)

Effect of application of microbial fertilizers

Research results on the effect of application of microbial fertilizers for increasing crop yield on some soils of Vietnam are elaborated on hereunder (Pham Van Toan 2002).

Microbial fertilizer for N fixation (MNF)

- ? Preparations (microbial fertilizer for symbiotic N fixation) of Rhizobia (commercial name, Nitragin) stimulated the growth and development of kidney beans and soybean plants:
- ? Peanut yield increased by 13.8-17.5% via Rhizobia preparations (fertilizers), depending on different soil types (Table 5). Rhizobium preparations can save significant mineral fertilizer use — about 30-60 N/ha (Table 6).

Table 5. The effect of Rhizobium preparations on peanut yield (results from Middle and Northern Vietnam)

Soil type	Treatments	Yield (kg/ha)		Compared with control	
		Control	With rhizobia	kg/ha	%
Degraded soil	NPK: 30.60.60 +5 tonnes FYM	1,972	2,272	300	1,152
Alluvial soil	NPK: 30.60.60 +5 tonnes FYM	2,310	2,631	321	1,138
Ferrallitic soil	NPK: 30.60.60 +5 tonnes FYM	1,576	1,952	376	1,238

FYM = farmyard manure

Table 6. Rhizobium preparations and saved mineral N (for peanut)

Treatments	Total pod /plant	Full pod /plant	yield (kg/ha)
NPK: 30.60.60 + 8 tonnes FYM + 400 kg powdered lime	15.5	7.0	1,861
NPK: 30.60.60 + 8 tonnes FYM + 400 kg powdered lime + Rhizobium	16.9	7.5	2,050
NPK: 60.60.60 +8 tonnes FYM + 400 kg powdered .lime + Rhizobium	16.9	7.2	1,850
NPK: 90.60.60 + 8 tonnes FYM + 400 kg powdered lime + Rhizobium	18.2	6.9	1,911

- ? Microbial fertilizer for MNF in maize, rice, tea (commercial name, Nizogin) can increase yields of some crops: maize 9.4-10.2%, rice 4.07-19.59%, tea 9.1-26.7% (Table 7).

Microbial fertilizers for soluble phosphate

These fertilizers can increase yields of some crops and enhance the effect of mineral phosphorus. They can also save about 30-40% of the amount of mineral phosphorus fertilizer used (Table 7) and still maintain the same crop yields.

Mixed microbial fertilizers for N fixation and soluble phosphate

These fertilizers can improve the yield of rice by 15.2-15.7% and soybean by 16.3-19.5%; farmers' income is also increased (Table 8).

Table 7. Microbial fertilizer for MNF effects on yields of some crops

Soil type	Crop	Treatments	Yield (kg/ha)	% increase compared to control
Alluvial soil	Rice	Control: NPK: 90.45.30 +8 tonnes FYM	5,160	-
		Control: 80%+ MNF	5,370	4.07
		Control : + MNF	5,780	12.02
	Maize	Control: NPK: 180.120.90 + 10 tonnes FYM	4,110	-
		Control: 80% + MNF	4,030	-2.66
		Control : + MNF	4,530	9.40
Degraded soil	Rice	Control: NPK: 90.45.30 + 8 tonnes FYM	2,960	-
		Control: 80% + MNF	3,440	16.22
		Control : + MNF	3,540	19.59
	Maize	Control: NPK: 180.120.90 + 10 tonnes FYM	2,950	-
		Control: 80% + MNF	2,870	-2.72
		Control : + MNF	3,250	10.20
Ferrallitic soil	Tea	Control: NPK: 120.60.60	14,290	-
		Control: 70% + MNF	15,100	9.10
		Control: + MNF	16,860	26.7

Table 8. The effect of mixed microbial fertilizer on rice

Crop	Treatments	In the narrow area		In the wide area	
		Yield (kg/ha)	% increase	Yield (kg/ha)	% increase
Spring crop	1. 100 N + 70 $P_2 0_5$ + 30$K_2 0$	3,810	-	3,606	-
	2. 80 N +25 $K_2 0$ + 526 ore + mixed microbial fertilizer	4,390	15.2	3,993	10.7
	LSD .05	3,240			
Summer crop	1. 90 N + 45 $P_2 0_5$ + 30 $K_2 0$	4,280	-	4,154	-
	2. 70 N + 25 $K_2 0$ + 526 ore + mixed microbial fertilizer	4,950	15.7	4,674	12.5
	LSD .05	5,250			

Utilization of vesicular-arbuscular mycorrhizal fungi (VAM) in Vietnam

Research on Mycorrhizae in Vietnam

Mycorrhiza is the symbiotic association of fungus with the roots of a seed plant. It is a widespread natural phenomenon (Harley 1983).

The Mycorrhizae have great influence on the growth and development of many kinds of crops/plants in nature and contribute to the sustained development of the soil environment. The role of Mycorrhizae in plant growth in general can be summarized as follows: (1) Mobilization of plant nutrients and water; (2) Increased carbon stream flow in trees; (3) Relationship with other soil microbial groups ((Sylvia 1998).

Mycorrhizology is a new field of research and application in Vietnam The paper by Nguyen Sy Giao in *Forest journal* about *Ectomycorrhiza* in pine roots published in 1976 was the first paper on research on Mycorrhiza in Vietnam.

In 1998, Nguyen Hong Ha published results of investigations on the VAM population of the rhizosphere in the roots of medicinal trees.

Hoang Thi Minh (2005) applied fungi spores of *Glomusin* to legumes on Bacgiang degraded soil. The experimental result showed that symbiotic fungi stimulated plant nutrient uptake to increase biomass and crop yields by about 10-12% compared to the control.

NguyenVan Suc *et al.* (2004/2005) published results of the distribution of VAM population in the roots of tea, pomelo, coffee and their rhizospheres. The research group established experiments to evaluate the effect of mycorrhizae on the growth of some industrial crops (tea, coffee).

Utilization of VAM

Vietnam has an agricultural area of 9,345,346 hectares (Statistics 2000); the areas growing annual and perennial industrial crops (maize, tea, fruit trees) occupy about 3,317,270 hectares of the total agricultural area. Our research concerned VAM use for tea.

The total tea planting area in Vietnam is around 122,000 hectares, distributed mainly in five regions and 34 provinces. Five provinces cultivate tea on more than 10,000 hectares — Lam Dong, Thai Nguyen, Ha Giang, Yen Bai and Phu Tho.

Dry yield tea averages nationwide are about 1,178.27 kg/ha or 5,288.72 kg freshweight /ha. The highest dry tea yield is in the uplands of Northern Vietnam and Tay Nguyen regions — on average 1,277.88 and 1,438.27 kg/ha respectively. Total tea production in the whole country in 2003 was 97,156.6 tonnes. Production in the aforesaid two regions comprised 66% of total production nationwide.

Currently, efforts are being concentrated on carrying out research on and application of mycorrhizae for crops in the uplands, where soil fertility is poor to very poor.

Special tea region in Tan Cuong, Thai Nguyen

A famous tea plantation with high yield and good quality is Tan Cuong (Thai Nguyen Province). Farmers in this region are experienced with intensive tea cultivation and tea processing. Mycorrhiza is needed to increase the quantity and quality of tea for this special tea region.

Soil in Tan Cuong is derived from schist rock, with slopes of 7-20°; elevation is about 30-100 m above sea level. The average air temperature is 21-23.3^{0}C and humidity is 78-86%.

The total tea area in Tan Cuong commune is 403 ha; Trung Dzu tea variety is cultivated on 360 ha (89%), other new varieties (TRI 777, LDP1, Kim Tuyen, Am Tich, Bat Tien) are grown on the remaining area.

Fertilizer use consists of: 330 N, 400 P_2O_5, 110 K_2O kg/ha/year mineral fertilizer, 10-12 tonnes of organic fertilizer and 20 tonnes of green manure/biomass for mulching. About US$1,666 ha/year is spent on fertilizer.

About 34% of the tea plantation is irrigated. The rest of the area is rain-fed.

The effect of Mycorrhizae on seedlings in the tea nursery

In 2004 mycorrhizae were applied in the tea nursery using the grafting technique on three tea varieties: Trung Dzu (local variety), PH1 (local selected new variety) and Bat Tien (an imported new variety from Taiwan).

Sixty thousand seedlings of each variety in this experiment were coated with mycorrhizae; the control treatment used no mycorrhizae. The research results can be summarized as follows:

- The seedlings coated with mycorrhizae in the three varieties had a shorter time in the nursery to transplanting (about 220-230 days) in comparison with control (250-260 days).
- The quality of seedlings was better in the treatments with mycorrhizae compared to control.
- The survival rate of seedlings (%) was better in the treatments with mycorrhizae (86%) compared to control (74.5%).
- With mycorrhizae coating, the selling price of one seedling (at the time of transplanting) was about US$0.018 compared to US$0.015/seedling with control.

The economic effect of mycorrhiza use in the nursery

Spent for 1,000 tea seedlings:

+ Preparations of mycorrhizae: US$1.88/kg (VND30,000)

+ Plastic bags: US$5.125 (VND82,000)

Income:(the selling of 1,000 seedlings x survival rate of seedling x price/seedling)

+ Control: 1,000 x 74.50% x 0.015 = US$11.18

+ Treatment with mycorrhizae: 1,000 x 86.00% x 0.018 = US$15.48

Net interest/1,000 seedlings:

+ Control: US$411.18 U$-5.125 = 6.055 U$

+ Treatment with mycorrhizae: 15.48-7.00 (1.88 + 5.12) = US$8.48

+ Compared to control: US$8.48 U$-6.055 U$=2.425 U$(increase 40%)

Tea seedlings with mycorrhizae planted in a non-irrigated area (2005-2006) grew faster than control (no mycorrhizae) and had high resistance to unfavourable conditions.

Currently we are extending the utilization of mycorrhizae for quality tea production in the special tea region in Tan Cuong, Thai Nguyen.

Assessment of production and application of biofertilizers in Vietnam

Microbial fertilizers have been studied and applied in Vietnam for more than 20 years, but production and application of biofertilizers is till difficult generally in Vietnam. Some constraints are:

- Lack of budget for R&D.
- Instruments and apparatus for R&D are very poor and non-systematic.
- The quality and type of microbial fertilizers are very poor, in other words microbial fertilizers work more slowly on plants than mineral fertilizers, therefore they do not interest farmers.

No domestic company wants to invest in producing microbial fertilizers. There is a good opportunity for foreign companies and research institutes to invest and cooperate in research and production of biofertilizers in Vietnam.

The way to develop biofertilizer application in Vietnam

Biofertilizers in Vietnam can make a good contribution to agricultural development; some related issues are listed hereunder:

- More funding and effective organization for research and application is needed.
- A relationship between research and production needs to be established.
- Technology transfer for microbial fertilizers in degraded eco-agricultural areas is recommended.
- Training and demonstrations for farmers on microbial fertilizer use are needed.
- Examine new ways for microbial fertilizer development. Encourage further cooperation among research institutes and information exchange.
- The production and application of microbial fertilizers in Vietnam should be promoted. There is good potential for multilateral cooperation in this field.
- More government attention to the biotechnology programme is needed. A major project on Development and Application of Biotechnology in Agriculture and Rural Areas to 2020 was approved on 12 January 2006.

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