Ministry of Education, Culture, Sports, Science and Technology (MEXT)
Forum for Nuclear Cooperation in Asia (FNCA) Biofertilizer Project

FNCA Biofertilizer Newsletter

Issue No. 14
March, 2016

Overview of FNCA Biofertilizer Project 2015

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In order to promote environmental friendly sustainable agriculture in Asia, FNCA Biofertilizer Project aims to develop biofertilizers with radiation sterilization technology, using benefical microorgamisms, which increase the yields of crops while reducing the environmental burden of excessive use of chemical fertilizers.

At the first phase of this project from 2001 to 2006, FNCA Biofertilize Manual was published, which gives information and experiences of biofertilizer use in Asian countries, including their effectiveness, efficient production processes, storage and application on different crops, as an important outcome.

At the second phase from 2007 to 2011, main objectives were 1) developing multifunctional biofertilizer having different two functions such as plant growth promoting and resistance against plant pathogens, and 2) dissemination of radiation sterilization method of carrier using ^{60}Co to improve quality of carrier for biofertilizers.

At the third phase from 2012 to 2014, above 2 objectives was enhanced and started a research focused on synergy effect between biofertilizer and irradiated oligochitosan as a new theme. Also “FNCA Guideline for Biofertilizer Quality Assurance and Control, Vol. 1 Quantification of beneficial microbes in biofertilizer” was published on the FNCA website in March 2014. This guideline can be a reference for the governmental or quasi-governmental organization which conducts the quality check of biofertilizer, and a standard method for microbial count in biofertilizer when biofertilizer companies register their products and sell them to the public market.

From 2015, forth phase was started to compile data of beneficial effects on irradiated carrieres and to have publication on the benefits. Synergy effect between biofertilizer and irradiated oligochitosan is also continued.

FNCA 2015 Workshop on Bifertilizer Project was held on November 24th - 27th in Bangkok, Thailand with 12 participants from 8 countries.

This is the first fiscal year of the forth phase and activity plan for the three years were reported by each member country. For the discussion on activity plan of this phase, it was agreed that the data of beneficial effects on irradiation carriers will be accummlated and published as articles on survival of beneficial microbes of biofertilizer in some member countries in 2015 and 2016. This scientific data will be included on “FNCA Guideline Vol.2 Production of biofertilizer carrier using radiation technology” and it will be published on the FNCA website before the end of this phase.

Technical Visit

Participants of the Workshop

Effect of Biofertilizers on crop yield increase in China

Fan Bingquan, Chinese Academy of Agricultural Sciences (CAAS)

In 2015, we conducted some activities focusing on carrier irradiation and development of high effective biofertilizer for sustainable Agriculture.

1. We conducted experiment to study the effect of P-solubilizing biofertilizers on maize biomass in greenhouse. The P41 biofertilizer showed a highest fresh and dry weight of maize biomass, the fresh and dry weight of maize increased by 91.8% and 211.8%, than that of control, respectively. The biofertilizer formulated from strain P250 got a 61.3% and 141.2% increase of maize biomass in fresh and dry weight than control, respectively. The other biofertilizers such as formulation of 13(1), A44 and C2 showed significant increase in biomass over control.

2. The biofertilizer carried with P-solubilizing fungi were used to conduct field experiment of sunflower in Inner Mongolia. All five kind of biofertilizers showed obvious effects on sunflower seed yields. Biofertilizer formulated by Aspergillus niger 5 achieved a highest yield averaged 201.3 kg/667m2, increasing 59.8% than control; biofertilizer from Aspergillus niger 4-2 got a increase of 27.6% over control.

Table 1 Effect of various biofertilizers on maize biomass

Strain	Treatment	Fresh weight (g/pot)	Increase%	Dry weight (g/pot)	Increase%
Control	no inoculation	5.451	-	0.68	-
20851	inoculation	7.21	18.2	1.01	48.5
P250	inoculation	9.84	61.3	1.64	141.2
13(1)	inoculation	9.33	53.0	1.23	80.9
A44	inoculation	8.72	43.0	1.23	80.9
C2	inoculation	8.31	36.2	1.61	136.8
P41	inoculation	11.70	91.8	2.12	211.8

Table 2 Effect of P-solubilizing fungi on sunflower yield

Strain	Seed yield kg/667m^2	Yield increase kg/667m^2	Increase percent %
CK (no inoculation)	126.0		
Aspergillus niger 5	201.3	75.3	59.8
Aspergillus niger 4-2	160.8	34.8	27.6
Penicillium oxalicum YZ1	148.1	22.1	17.6
Aspergillus niger C2	142.5	16.5	13.1
Aspergillus niger Wu5	141.2	15.2	12.0

3. A field experiment of tomato treated with 5 kind of biofertilizers in greenhouse was conducted in Shandong Province. Three kind of biofertilizers got higher yields than control. The tomato yield of biofertilizer formulated by strain Y16 averaged 3003.0 kg/667m^2 was the highest over other four biofertilizers. The average yields of tomato treated with JQ1 biofertilizer was 2596.2 kg/667m^2 and increased by 35.0% over control; application of J15 biofertilizer achieved a higher yield than control, the yield enhancement was 24.3%.

4. We conducted peat carrier irradiation sterilization by using 60Co γ-ray, the irradiated dose are 0, 20, 35, 50, 75, 100, 200 and 300kGy. The effect of γ-ray irradiation doses on peat sterilization in indigenous microorganisms was significant different, the higher γ-ray irradiation dose, the lower number of microorganism in peat.

Table 3　Effect of biofertilizers on tomato yield (the mean of two harvests)

Strain	Seed yield kg/plot	Seed yield kg/667m^2	Yield increase kg/667m^2	Increase %
Y16	10.2	3003.0	931.8	42.4
JQ1	11.38	3340.7	866.4	35.0
J15	8.8	2596.2	525.0	24.3
JK24	7.7	2271.7	200.5	11.6
JK8	7.5	2208.5	137.3	6.2
CK	7.1	2071.2	0.0	0.0

Table 4　Effect of irradiation doses on sterilization of peat indigenous microorganisms

^{60}Co γ-ray irradiation doses (kGy)	PDYA (×10^{4}cfu/g)	Bacteria (×10^{4}cfu/g)	Actinomyces (×10^{3}cfu/g)
20	205.3a	400.0 a	0.0 c
35	37.7b	72.7 b	6.3a
50	0.0d	0.0 d	0.0 c
75	1.0c	3.3 c	3.3b
100	3.7c	4.0 c	0.0 c
200	0.0d	0.0 d	0.0 c
300	0.0d	0.0 d	0.0c

Partly Substitution of Chemical Fertilizers with Bio-organic Fertilizer for Rice

Dr. Iswandi Anas and M.D. Megarani, Bogor Agricultural University (IPB), Indonesia

Introduction

Conventional rice cultivation in Indonesia are characterized by (1) using very high amount of agrochemicals namely chemical NPK fertilizers and pesticides, (2) always using flooding irrigation water, (3) almost no application of organic fertilizer, and (4) very intensive cropping system with almost three times growing season a year. Such rice cultivation have been practiced since earlier seventies. Many scientists have been reported concerning soil degradation, levelling-off of rice yield, more often pest and diseases outbreak, in balance use of chemical and bio-organic fertilizers and environmental pollution (Bakrie *et al.* 2010).

Recently, System of Rice Intensification (SRI), rice cultivation with less inputs (seeds, chemical fertilizers, pesticides, water) have been practiced by famers widely (Uphoff, 2007 and Iswandi *et al*, 2009). Basic principles of SRI rice cultivation method are (1) planting a young seedling 8-12 days old, (2) wider planting distance of 25 cm x 25 cm, (3) no flooding irrigation water, soil just moist, (4) preferably organic fertilizer is used as addition to chemical fertilizers. Experiment was carried out at Muara Ministry of Agriculture Rice Research Station, District Bogor, West Java, Indonesia. Treatments were (1) 100% NPK chemical fertilizers (250kg Urea, 100kg SP-36 and 100kg KCl per ha, (2) 50% NPK chemical fertilizers (125kg Urea, 50kg SP-36 and 50kg KCl per ha PLUS 300kg Bio-organic Fertilizer BIOST per ha, and (3) 50% NPK chemical fertilizers (125kg Urea, 50kg SP-36 and 50kg KCl per ha. Bio-organic Fertilizer used contain organic fertilizer enriched with *Azotobacter* sp, *Azospirillum* sp, phosphate solubilizing fungus and antagonist *Trichoderma* sp The treatments had four replicates.

Results

Results showed that the treatment 100% NPK chemical fertilizers had significant ly more productive tillers numbers and grain yield compared to 50% NPK chemical fertilizers only (Table 1 and 2). This means that 50% NPK fertilizers was not enough to support good rice growth and higher yield (Figure 1 and Figure 2). On the otherhand, mixed between chemical fertilizers with bio-orgic fertilizer produced significantly higher productive tillers compared to 100% NPK fertilizer although there was no statistically difference in grain yield between treatment 100% NPK chemical fertilizers and treatment 50% NPK plus Bio-organic Fertilizer. Numbers of grains per panicle and the number of grains per hill of rice treated with mixed chemicals and bio-organic fertilizers was significantly higher than those treated with 100% NPK chemical fertilizers. This means that 300kg bio-organic fertilizer BIOST can substituted 50% NPK chemical fertilizers.

References

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Figure 1. Rice treated with 100% NPK chemical fertilizers (left) 50% NPK fertilizers plus Bio-organic fertilizers (middle) and 50% NPK chemical fertilizers (right)

Figure 2. Rice growth treated with NPK chemical fertilizers and mixed between chemical fertilizers with bio-orgnic fertilizers

Table 1. Effect of partly substitution of chemical fertilizers with bio-organic fertilizer on the number of productive tillers

Treatments	Plant age (days after transplanting)			
	28	42	56	70
100% NPK	16.90a	24.50b	35.05b	27.40b
50% NPK +BOF1	16.10a	33.15c	38.45c	30.20c
50%NPK	8.60b	14.05a	22.00a	17.30a

Table 2. Effect of partly substitution of chemical fertilizers with bio-organic fertilizer on the number of productive

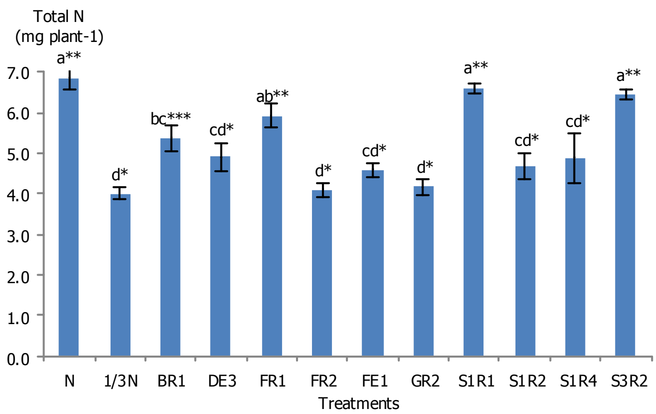
Treatments	Grain Yield (ton/ha)
100% NPK	5.23ab
50% NPK+BOF1	6.35b
50%NPK	4.05a

BOF= Bio-organic fertilizer BIOST at 300 kg per ha

Biofertilizer News from Malaysia 2015

Khairuddin Abdul Rahim, Phua Choo Kwai Hoe, Rosnani Abdul Rashid
Malaysian Nuclear Agency (Nuclear Malaysia)

The trend on chemical fertilizer usage in Malaysia will continue to rise if cultivated areas and the intensity of production continue to increase. However, there is a possibility to minimize rate of increase in fertilizer use if technologies such as variable rate application and site-specific management of soil nutrient and water are extensively and rigorously practiced. The current government subsidies of agricultural inputs for farmers are mostly for agrochemicals; hence bioproducts, including biofertilizers will have to show their consistency in effectiveness and economic returns before becoming acceptable in large scale farming systems, such as for oil palm, rubber and rice. Practice of agroforestry, intercropping, integrated farming systems (animals and crops) and use of agricultural residues, in addition to specific niche market pull, would reduce dependency on chemical fertilizers.



Effects of PGPR inoculations on Total N uptake of maize seedlings. Different letter(s) on the bar indicate(s) significant difference by DMRT; * and ** on the bar indicates significant difference by Dunnett's test comparisons with T1 and T2 respectively; p=0.05. (source: Kuan Khing Boon et al. 2015).

Research on biofertilizer continues to be strong, with new interests on fundamental research especially in the academia. Prof. Dr. Zulkifli Haji Shamsuddin, Assoc. Prof. Dr. Radziah Othman, Assoc. Prof. Dr. Halimi Mohd Saud, Dr. Tan Kee Zuan and Kuan Khing Boon, authored scientific papers during the year. The work included on diazotrophs, plant growth promoting rhizobacteria and mycorrhiza. Findings include as below.

Currently, not all biofertilizer formulations in Malaysia utilise sterilised carriers as host for the microbial inoculants. Some prefer to use liquid formulation for ease of use e.g. in padi fields. The storage time for the products has been reported to be more than 12 months. The plastic containers or bottles can be gamma sterilised and the economics is evaluated. Examples of products are Bacto-10 from PhytoGold Sdn. Bhd, and BioLiquiFert from Nuclear Malaysia

Figure 1: Yield estimation MR 219-4 (t/ha), MADA, Kedah

Bacto-10

BioLiquiFert

Biofertilizer Research and Development in 2015

Delgermaa Bongosuren, Institute of Plant and Agricultural Sciences (IPAS)

In Mongolia most soils are low in nitrogen and phosphorus and the all chemical fertilizers are imported. The large-scale crop enterprises grow mainly wheat and potato.

At present new varieties of wheat and potatoes are being used by farmers. The need for generating more data on the response of biofertilizer to new varieties is very essential to convince more farmers on the Rhizobacterial biofertilizer usage. 3.5 tons of biofertilizer is produced and distributed to farmers in this year.

The plant growth promoting Rhizobacteria biofertilizer produced for wheat, potatoes and tomato. The result of field test concluded that biofertilizer used efficiency for 25%. Biofertilizer produced by using beneficial microorganisms have a positive economic impact in terms of biofertilizer saving and increasing the crop yield. Biofertilizer produced by using beneficial microorganisms have a positive economic impact in terms of nitrogen fertilizer saving and increasing the crop yield. The field trial and demonstration showed, that biofertilizer are able to increase crop yield from 15- 28.5%, save 20-25% of required chemical N and P fertilizers. Biofertilizer production and application, many technical trainings for farmers, field days and biofertilizer communication in mass media like TV, radio.

Commercialization of Rhizobacterial fertilizer

№	Provinces	Total area/ha/	Yields t/ha	Yield addition	
				t/ha	%
1	Selenge province, 2002-2005	1,400	1.27	0.38-0.45	49.4
2	Bulgan province, 2004-2015	8,000	1.62	0.42-0.7	35.2-45.3
3	Darkhan-Uul province, 2003-2005	1,000	0.94	0.21	25,3
4	Uvs province, 2003-2005	2,500	2.54	0.50	30.0
5	Dornod province, 2014-2015	2,000	2.2	0.20-0.50	22.7-35.5

Figure 2. Field experiment and demonstration on the benefit of biofertilizer

Figure 1. Agricultural Exhibits/Conventions/Forum

Summary of Philippines Country Report on Biofertilizer Research and Development in 2015

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Introduction

Biofertilizer is a substance containing living microorganisms which, when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant (Vessey, 2003). Biofertilizers are generally applied to soil, seeds or seedlings, without or with some carrier medium for the microorganisms. Bio N^{TM} is a microbial-based fertilizer that contains Azospirillum as its major component and soil and charcoal as its carrier while Mykovam^{TM} is a soil based-biofertilizer which contains mycorrhizal fungi that form symbiotic association with plants. In this study biofertilizers were integrated to evaluate the effects and compared the response of the test plant tomato and eggplant in biofertilizers inoculation.

Materials and methods:

In this study two experiments were conducted one for tomato and eggplant. The treatments for tomato wereT$_1$ – Control T$_2$ – Full Chemical Fertilizer, , T$_4$ – Bio N, T$_5$ – Bio N + Mykovam and T$_6$ – Bio N +1/2 RR For eggplant, the treatments were T$_1$ – Control, T$_2$ – Full chemical fertilizer, T$_3$ – Full chemical + Bio N, T$_4$ - 1/2 Chemical + Bio N, T$_5$ – Full chemical + Mykovam, T$_6$ – Mykovam + Bio N, T$_7$ - ½ Chemical fertilizer + Mykovam and T$_8$ - ½ Chemical + Mykovam + Bio N.

Results:

The data revealed that plants applied with less fertilizer in combination with Bio N and Mykovam was heavier that those plants with full chemical fertilizers (T2). The application of the combination of Bio N and Mykovam contributed to the yield of the test plant. *Bio N* aside from being a nitrogen supplement also promotes root hair development help plants uptake of NPK and microelements while Mykovam increase water and phosphorous absorption.

Figure 1. The experimental site of tomato and eggplant at BIOTECH-demo farm, DS, 2015

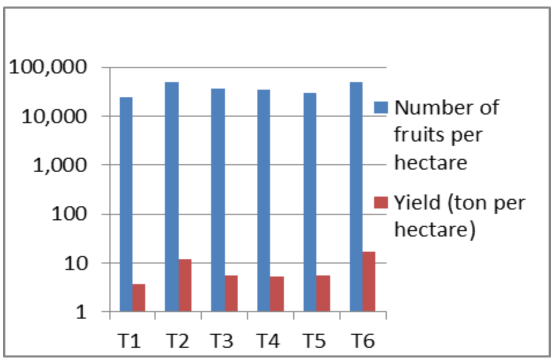

Figure 2. Response of tomato on biofertilizer inoculation

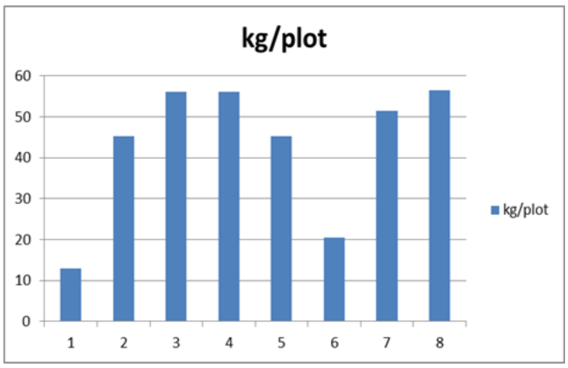

Figure 3. Effect of biofertilizer and chemical on the yield of eggplant

Summary of Vietnam Country Report on Multifunctional Biofertilizer Research and development in 2015

Pham Van Toan, Ministry of Agriculture and Rural Development (MARD)

1. Introduction

Like other provinces in costal marine area Vietnam, Binhdinh province has a large sandy soil area, which are low in organic matter as well as nutritional concentration and very dry. To develop the biofertilizer used for sandy soil, we continue the research of effect of multifunctional biofertilizer on the nutrition uptake and yield of peanut cultivated in sandy soil.

2. Material and methods

Biofertilizer for sandy soil contained N-fixer Bradyrhizobium japonicum, P-solubilizer Bacillus megaterium, Cilicate solubilizer Paenibacillus castaneae and polysaccharid producer Lipomyces starkeyi with the density of more than 108 CFU/gram is used in the study. Green house and field trial were conducted with folows treatments: 1. Base fertlizer (100% NPK: 30.60.90), 2. 100% NPK (30.60.90) + Biofertilizer, 3. 90% NPK (30.60.90) + Biofertilizer, 4. 80% NPK (30.60.90) + Biofertilizer . and 5. 70% NPK (30.60.90) + Biofertilizer. Each treatments was innoculated with single strait to evaluate the effect of microbes on the nutrition uptake of plant. To evaluate the effect of multifuntional biofertilizer on yield of peanut and the economical effect of peanut production, the mixculture was to innoculate to all treatments.

3. Results

The green house experiments showed that beneficial microbes can increase 30% of N, P, K uptake of peanut. Multifunctional biofertilizer can save 30% requred mineral NPK in the peanut production (Figure 1).

As results of multi-functional biofertilizer on yield of peanut in sandy soil of Binhdinh province can be see that the biofertilizer and reduction of 30% of required NPK have no change of peanut biomass and pod yield in the field condition. Biofertilizer bring benefit for peanut cultivated farmer in the sandy soil area.

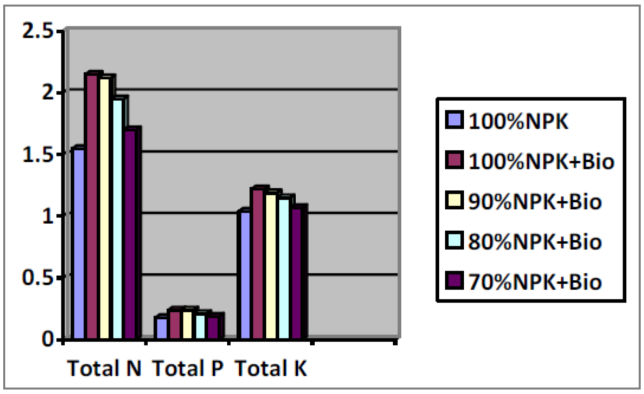

Figure 1. The effects of biofertilizer on the NPK uptake of peanut cultivated in sandy soil

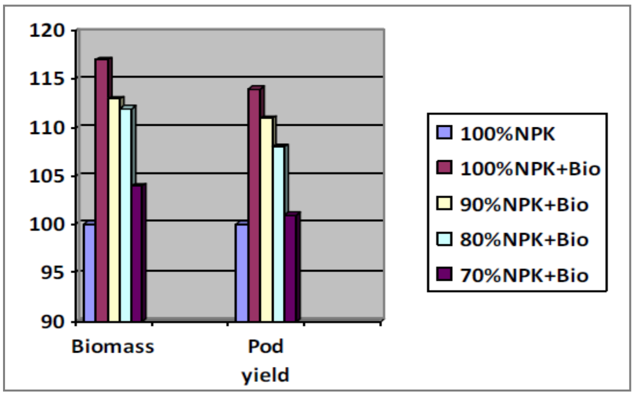

Figure 2. The effects of biofertilizer on the yield of peanut cultivated in sandy soil

Figure 3. Green house and field experiments on the benefit of biofertilizer on the peanut production in sandy soil of Binhdinh province