

THE EFFICIENCY OF USING THE RICE STRAW COMPOST TREATED WITH *TRICHODERMA* SPP., NITROGEN-FIXING AND PHOSPHORUS DISSOLVED BACTERIA IN RICE PRODUCTION OF HAU GIANG

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ABSTRACT

The research was conducted in 3 communes of Truong Long Tay, Chau Thanh A district, Long Binh, Long My district and Vi Thanh, Vi Thuy district of Hau Giang province, Vietnam in the Winter-Spring 2011-2012 and Summer-Autumn 2012. The experiment compared 7 fertilizer treatments that included varying amounts of NPK fertilizer with and without 6 t/ha of the rice straw compost that was treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria. Use of NPK fertilizer at 20% of the recommended application in combination with rice straw compost increased the yield from 0.13 to 0.25 t/ha in the Winter-Spring 2011-2012 and from 0.17 to 0.28 t/ha in the Summer-Autumn 2012 over 3 communes. The net benefit of this treatment was greater than application of inorganic fertilizer at the recommended rate by 2.949 million VND/ha (12.3%) in the Winter-Spring 2011-2012 and 2.438 million VND/ha (27.1%) in the Summer-Autumn 2012. Application of NPK at 80% of recommended dosage combined with 6 t/ha of the rice straw compost that was treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria was the best recommendation for rice production towards bio-organic of Hau Giang.

Keywords: farmers' fertilizer practice, net benefit, nitrogen-fixing and phosphorus dissolved bacteria, recommended fertilizer practice, recommended dosage, the rice straw compost, *Trichoderma* spp.

INTRODUCTION

Rice is the staple food in Vietnam with a production area of nearly 8 million ha. The Mekong Delta has a production area of 3.8 million ha. Hau Giang is one of 13 provinces with a large area of intensive rice production of 2-3 crops/ year. Hau Giang also gets high rice yield at some districts such as Vi Thanh town, Vi Thuy district, Long My district, and Chau Thanh A district; however, cultivation of 2-3 consecutive crops per year and use of high doses of chemical fertilizers for a long period causes declines in soil nutrient supply. The current trend is towards bio-organic rice production in combination with organic fertilizers. This method not only reduces chemical fertilizer use by 20-80% but also increases the yield and profit (Son *et al.*, 2008; Man *et al.*, 2010). The research "Using the rice

straw compost that was treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria in rice production of Hau Giang" is a case study of methods to improve and maintain sustainable intensive rice production.

MATERIALS AND METHODS

The experiment was designed in the On-farm trial over 2 seasons (Winter-Spring 2011-2012 and Summer-Autumn 2012). The experiment included 7 treatments comparing of farmers' fertilizer Practice (FFP) with a Recommended Fertilizer Practice (RFP) to reduce the applied chemical fertilizer by using rice straw compost that was treated with *Trichoderma* spp., nitrogen fixing and phosphorus dissolved bacteria; and other microorganism fertilizer of DASVILA on the variety of OM 6976 (Table 1).

Table 1. Description of the experimental treatments

No	Treatments	Description
T1	100% NPK by FFP (Control 1)	100% NPK fertilizers by farmers' practices [121-44-52 kg N-P ₂ O ₅ -K ₂ O/ha (Autumn-Spring) and 94-57-57 kg N-P ₂ O ₅ -K ₂ O/ha (Summer season)]
T2	100% of the recommended NPK (Control 2)	100% chemical fertilizer at the recommended dosage [100-40-40 kg N-P ₂ O ₅ -K ₂ O/ha (DS) and 80-50-50 kg N-P ₂ O ₅ -K ₂ O/ha (Summer season)]
T3	80% NPK (recom.) + rice straw compost	80% chemical fertilizer at the recommended dosage + rice straw compost treated with <i>Trichoderma</i> spp., nitrogen-fixing and phosphorus dissolved bacteria (6 t/ha)
T4	60% NPK (recom.) + rice straw compost	60% chemical fertilizer at the recommended dosage + rice straw compost treated with <i>Trichoderma</i> spp., nitrogen-fixing and phosphorus dissolved bacteria (6 t/ha)
T5	40% NPK (recom.) + rice straw compost	40% chemical fertilizer at the recommended dosage + rice straw compost treated with <i>Trichoderma</i> spp., nitrogen-fixing and phosphorus dissolved bacteria (6 t/ha)
T6	80% NPK (recom.) + DASVILA	80% chemical fertilizer at the recommended dosage + rice seed treatment before sowing by DASVILA (10 kg/ha)
T7	80% NPK (recom.) + treated directly rice straw on the field by <i>Trichoderma</i> spp.	80% chemical fertilizer at the recommended dosage + using <i>Trichoderma</i> spp. to spray directly on rice straw of the paddy field that was harvested by Combine Harvester

The experimental soil was a loamy alluvium with containing 40% sand, 51% silt and 9% clay at 0-20 cm layer and 40% sand, 49% silt and 11% clay at 20-40cm layer. The chemical properties of soil were low in organic C and total N, medium-high in P, low-medium in K, low in Ca and Mg, no micro-nutrients deficiency and no soil toxicity.

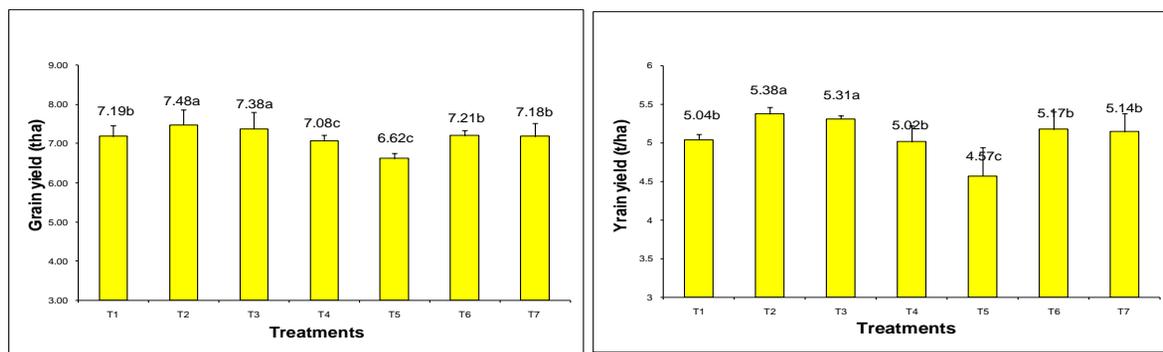
Data of yield components and grain yield were collected and calculated followed by IRRI, 1995.

RESULTS AND DISCUSSIONS

Effect of the rice straw compost treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria on grain yield

Experimental results in the Winter-Spring 2011-2012 and Summer Autumn 2012 at Long Binh

commune, Long My district, Hau Giang province was shown in Figure 1. The treatment using a 20% reduction in chemical fertilizer plus 6 t/ha of the rice straw compost treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria (T3) got a higher yield compared to T1 (farmers' fertilizer practice - FFP) at the 5% significant level, and got the same yield as the treatment that applied 100% NPK at the recommended dosage (T2). This means fertilization of the rice straw compost treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria helped to save 20% chemical fertilizer and protected the environment by avoiding the burning of a large amount of these rice straw.



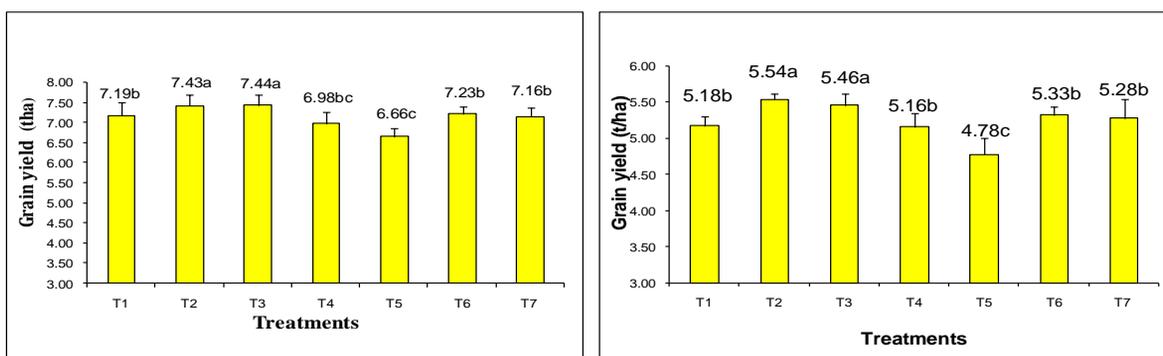
Long Binh, Summer-Autumn 2012

Long Binh, Winter-Spring 2011-2012

Figure 1. Effect of the rice straw compost treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria on grain yield of OM 6976 in Winter-Spring 2011-2012 and Summer-Autumn 2012 at Long Binh, Long My, Hau Giang

The same results were found in Truong Long Tay and Vi Thanh (Figure 2 and 3). They confirmed again the efficacy of using of rice straw compost treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria at the T3 treatment. Applying the same NPK fertilizer at 80% of the recommended dosage in combination with rice seed treatment before sowing by DASVILA (10 kg/ha) (T6) and in combination with spraying *Trichoderma* spp. directly on rice straw of the paddy field that was harvested by Combine Harvester (T7), gave lower grain yields that were significantly different from T2 and T3. Treatment 3 involves the interaction of nitrogen-fixing and

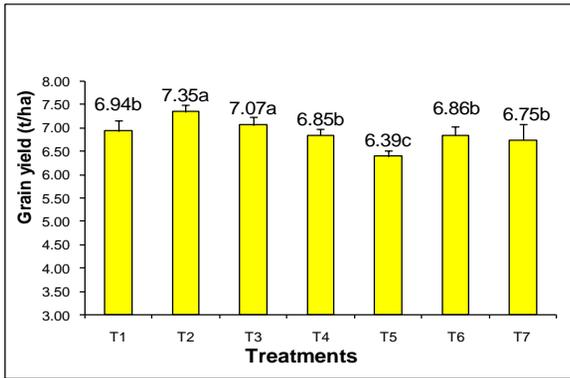
phosphorus dissolved bacteria clearly expressed in combination with *Trichoderma* spp. in the rice straw compost compared to T7, which sprays only *Trichoderma* spp. directly to the field. The difference of grain yield between two these treatments was from 0.20 t/ha to 0.32 t/ha in Winter-Spring 2011-2012 and from 0.15 t/ha to 0.18 t/ha in Summer-Autumn 2012. Reducing NPK application by 40-60% from the recommendation dosage in the T4 and T5 treatments, produced yields that were reduced significantly compared with T2 and T3 in both seasons due inadequate supply of nutrients for rice development and yield.



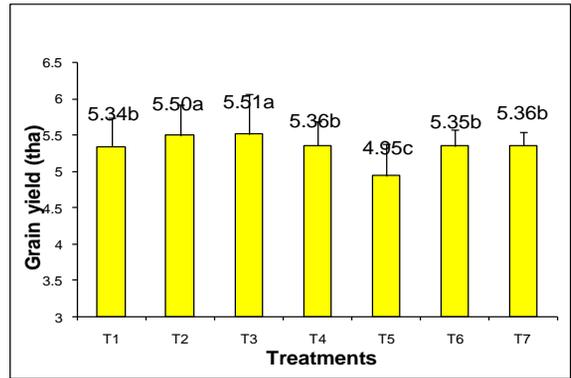
Truong Long Tay, Autumn-Spring 2011-2012

Truong Long Tay, Summer-Autumn 2012

Figure 2. Effect of the rice straw compost treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria on grain yield of OM 6976 in Winter-Spring 2011-2012 and Summer-Autumn 2012 at Truong Long Tay, Chau Thanh A, Hau Giang



Vi Thanh, Winter-Spring 2011-2012



Vi Thanh, Summer-Autumn 2012

Figure 3. Effect of the rice straw compost treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria on grain yield of OM 6976 in Winter-Spring 2011-2012 and Summer-Autumn 2012 at Vi Thanh, Vi Thuy, Hau Giang

Economic efficiency of the rice straw compost treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria

Among the seven treatments, treatment T3 produced highest net economic benefit (26.754 million VND/ha), 2.929 million VND/ha or 12.3% higher than the net benefit of T1 of. The net benefit of treatment T2 was 26,909 million VND/ha, 3.084 million VND/ha or 13.0% higher than T1. Application of 80% NPK fertilizer at recommended dosage and seed

treatment before sowing by DASVILA (10 kg/ha) (T6), and the T7 treatment of 80% chemical fertilizer at the recommended dosage and using *Trichoderma* spp. to spray directly on rice straw of the paddy field that was harvested by Combine Harvester gave net benefit of 1,709 million vnd/ha (7.1%) and 1,291 million vnd/ha (5.3%) greater than T1, respectively. The two treatments T4 and T5 that used 40 and 60 percent reductions from the recommended rate of NPK chemical fertilizer also gave increased net benefit over T1 of 8.5% and 1.5% (Table 2).

Table 2. Economic efficiency of using the rice straw compost treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria in Winter-Spring 2011-2012

Parameters	Treatments						
	T1	T2	T3	T4	T5	T6	T7
Grain yield (T/ha)	7.14	7.42	7.30	6.97	6.56	7.10	7.03
Gross benefit (1,000 VND/ha)	43,542	45,265	44,518	42,505	40,004	43,298	42,880
Cost of fertilizers (1,000 VND/ha)	5,570	4,209	3,617	2,525	1,684	3,617	3,617
Cost of pesticides (1,000 VND/ha)	4,473	4,473	4,473	4,473	4,473	4,473	4,473
Cost of labor (1,000 VND/ha)	7,933	7,933	7,933	7,933	7,933	7,933	7,933
Cost of seeds (1,000 VND/ha)	1,740	1,740	1,740	1,740	1,740	1,740	1,740
Total cost (1,000 VND/ha)	19,717	18,356	17,764	16,672	15,830	17,764	17,764
Net Benefit (1,000 VND/ha)	23,825	26,909	26,754	25,832	24,173	25,534	25,116
Difference in net benefit vs. T1 (1,000 VND/ha)	-	3,084	2,929	2,007	348	1,709	1,291
Increased net benefit vs T1 (%)	-	13.0	12.3	8.5	1.5	7.1	5.3

In the Summer-Autumn 2012, using the rice straw compost gave the same pattern but higher overall percentage increases in net benefit. Among the treatments that applied NPK fertilizer in combination with organic fertilizer from the rice straw compost treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria, treatment T3 using 80% of the recommended NPK dosage gave 27.1% increased profit while T6 that applied 80% of the recommended NPK fertilizer with seed treatment before sowing by DASVILA gave a 17.9% increase, and the T7

treatment of 80% chemical fertilizer plus using *Trichoderma* spp. to spray directly on rice straw of the paddy field that was harvested by Combine Harvester gave a 14.4% increase compared to T1. Treatment T4 using a 40% reduction in NPK chemical fertilizer 21.5% greater net benefit compared to T1. Using a 60% reduction of NPK chemical fertilizer with 6 t/ha of the rice straw compost treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria gave a 6.0% higher net profit than T1 (Table 3).

Table 3. Economic efficiency of using of rice straw compost treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria in Summer-Autumn 2012

Parameters	Treatments						
	T1	T2	T3	T4	T5	T6	T7
Grain yield (t ha ⁻¹)	5.19	5.47	5.43	5.18	4.77	5.32	5.26
Gross benefit (1,000 VND/ha)	28,009	29,556	29,307	27,977	25,735	28,740	28,417
Cost of fertilizers (1,000 VND/ha)	4,515	4,220	3,376	2,532	1,688	3,626	3,626
Cost of pesticides (1,000 VND/ha)	4,552	4,552	4,552	4,552	4,552	4,552	4,552
Cost of labor (1,000 VND/ha)	8,137	8,137	8,137	8,137	8,137	8,137	8,137
Cost of seeds (1,000 VND/ha)	1,740	1,740	1,740	1,740	1,740	1,740	1,740
Total cost (1,000 VND/ha)	18,944	18,648	17,804	16,961	16,117	18,054	18,054
Net Benefit (1,000 VND/ha)	9,065	10,907	11,503	11,016	9,618	10,686	10,362
Difference in net benefit vs T1 (1,000 VND/ha)	-	1,842	2,438	1,951	553	1,620	1,297
Increased net benefit vs T1 (%)	-	20.6	27.1	21.5	6.0	17.9	14.4

CONCLUSION

In both seasons, the best treatment was T3, that applied 80% of the recommended dosage [80-32-32 kg N-P₂O₅-K₂O/ha (Winter-Spring) and 64-40-40 kg N-P₂O₅-K₂O/ha (Summer-Autumn)] and 6 T/ha of the rice straw compost treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria for getting high grain yield and net benefit of rice production in 3 communes of Hau Giang.

Using the rice straw compost that was treated with *Trichoderma* spp., nitrogen-fixing and phosphorus dissolved bacteria in rice production of Hau Giang helped to improve and sustainably maintain the intensive rice production.

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TÓM TẮT

Sử dụng các dòng nấm *Trichoderma*, vi khuẩn cố định đạm và hòa tan lân để xử lý rơm rạ thành phân hữu cơ vi sinh bón cho ruộng lúa sản xuất theo hướng hữu cơ ở Hậu Giang

Nghiên cứu đã được thực hiện ở 3 xã Trường Long Tây, huyện Châu Thành A; xã Long Bình, huyện Long Mỹ và xã Vị Thanh, huyện Vị Thủy, tỉnh Hậu Giang, Việt Nam trong 2 vụ ĐX2011-2012 và HT2012. Thí nghiệm với 7 nghiệm thức bao gồm phương pháp bón phân theo nông dân và theo khuyến cáo với 100% NPK hóa học, so sánh với các nghiệm thức có sử dụng 6 t/ha phân rơm rạ xử lý nấm *Trichoderma*, vi khuẩn cố định đạm và hòa tan kết hợp với giảm từ 20% đến 60% phân hóa học của liều lượng NPK khuyến cáo. Kết quả nghiên cứu cho thấy rằng nghiệm thức giảm 20% phân NPK ở liều lượng khuyến cáo kết hợp với sử dụng phân rơm rạ xử lý nấm *Trichoderma*, vi khuẩn cố định đạm và hòa tan lân đã giúp gia tăng năng suất lúa từ 0,13-0,25 tấn/ha trong vụ ĐX2011-2012 và tăng từ 0,17-0,28 t/ha trong vụ HT2012 ở cả 3 xã nghiên cứu. Mặt khác, sự chênh lệch lợi nhuận của nghiệm thức này so với phương pháp bón phân của nông dân đạt được 2,949 triệu đồng/ha (tương đương 12,3%) trong vụ ĐX2011-2012 và đạt 2,438 triệu đồng/ha (27,1%) trong vụ HT2012. Nghiệm thức bón 80% phân hóa học theo mức khuyến cáo kết hợp với sử dụng phân hữu cơ từ rơm rạ đã xử lý nấm *Trichoderma*, vi khuẩn cố định và hòa tan lân là nghiệm thức tốt nhất được khuyến cáo cho sản xuất lúa theo hướng hữu cơ sinh học, giúp cải thiện và duy trì sản xuất lúa thâm canh bền vững của tỉnh Hậu Giang.