EFFECT OF PEST CONTROL METHODS ON SUSTAINABLE RICE PRODUCTION TOWARDS BIO-ORGANIC STANDARDS IN TRA VINH

Tran Thi Ngoc Huan[1], Trinh Quang Khuong[1], Tran Thi Kieu Trang[1], Nguyen Viet Thao[2] and Nguyen Minh Tuan[2]

[1]Cuu Long Delta Rice Research Institute, Can Tho, Vietnam
[2]People Union of Chau Dien commune, Cau Ke district, Tra Vinh, Vietnam

ABSTRACT

The research on pest control methods in sustainable rice production towards meeting bio-organic standards was conducted at Chau Dien commune, Cau Ke district, Tra Vinh province in DS 2011-2012 and WS 2012. The experiments consisted of 7 treatments that combined management practices and Integrated Pest Management (IPM). Pesticide treatments included use of only chemical pesticides, only bio-insecticides and IPM with chemical or bio-insecticides. The two treatments that applied IPM combined with bio-insecticides and spraying chemicals combined with bio-insecticides when the threshold is reached attained the highest efficiency in both plant protection and economic effect. The BPH population, the percentage of damaged rice leaves by leaf folder and the percentage of damaged rice leaves by blast were lower than for other pest control methods. The increased net benefits of these two pest control methods were higher by 4.61 million VND/ ha and 5.19 million VND/ha than those of Farmers' Practices only using of chemicals in DS2011 -2012. They also got higher net benefits of 4.49 million VND/ ha and 4.81 million VND/ ha in WS2012, respectively.

Keywords: *Bio-insecticides, Bio-Organic, Pest Control Methods, Sustainable Rice Production, Vietnamese Good Agricultural Practices (VietGAP).*

INTRODUCTION

In the recent years, in addition to use of IPM in intensive rice production, application of bio-pesticides was developed for increased safety and environmental benefit. In the Mekong Delta, a research group (Nguyen Thi Loc *et al.*, 2002; Nguyen Thi Loc, 2006; Nguyen Thi Loc, 2007; Nguyen Thi Loc *et al.*, 2012) produced the bio-product Ometar and transfered its production procedure to the farm level for control of Brown Plant Hopper (BPH) and other pests. Use of pesticides and fertilizers have considerable effects on the enviroment and the quality of products and is an important criterion in the VietGAP standards of rice production (MARD, 2010). To intensify the overall implementation of advanced technologies in high quality rice production over large areas and to improve the process of sustainable rice production towards meeting bio-organic and VietGAP standards, this study on pest control methods was conducted at Chau Dien commune, Cau Ke district, Tra Vinh province to recommend pesticide use levels in order to save the cost of pesticides and increase farmers' profit.

MATERIALS AND METHODS

The experiment was designed as an on-farm trial with 3 replications of three farmer fields in each of 2 seasons: DS 2011-2012 and WS 2012. The 7 testing treatments were presented in Table 1.

Data were collected and processed by the procedures of IRRI, 1994 and 2002. Data were analyzed using SPSS 10.05 and IRRISTAT for WINDOW 5.0 with Duncan test (DMRT).

Table 1. Description of pest control methods

No	Pest control methods
T1	Application of Farmer Management Practices* and only using chemical pesticides for pest control
T2	Application of Farmer Management Practices* and using chemical pesticides + bio-insecticides for pest control
T3	Application of Recommended Management Practices** and only using bio-insecticides for pest control
T4	Application of Recommended Management Practices** and using IPM for pest control
T5	Application of Recommended Management Practices** and using IPM + bio-insecticides for pest control
T6	Application of Recommended Management Practices** and spraying chemical pesticides when reach the threshold for pest control
T7	Application of Recommended Management Practices** and spraying chemical pesticides + bio-insecticides for pest control when reach the threshold.

**Farmer Management Practices: broadcast seeding at 200 kg/ha, fertilization at 120-60-48 kg N-P_2O_5-K_2O/ha (DS), 100-60-50 kg N-P_2O_5-K_2O/ha (WS);*

*** Recommendation Management Practices: row seeding at 120 kg/ha, fertilization at 100-40-40 kg N-P_2O_5-K_2O/ha (DS), 80-50-50 kg N-P_2O_5-K_2O/ha (WS).*

RESULTS AND DISCUSSIONS

Effect of pest control methods on pest population and the rate of damaged rice leaves by some rice pest in DS 2011-2012 and WS 2012

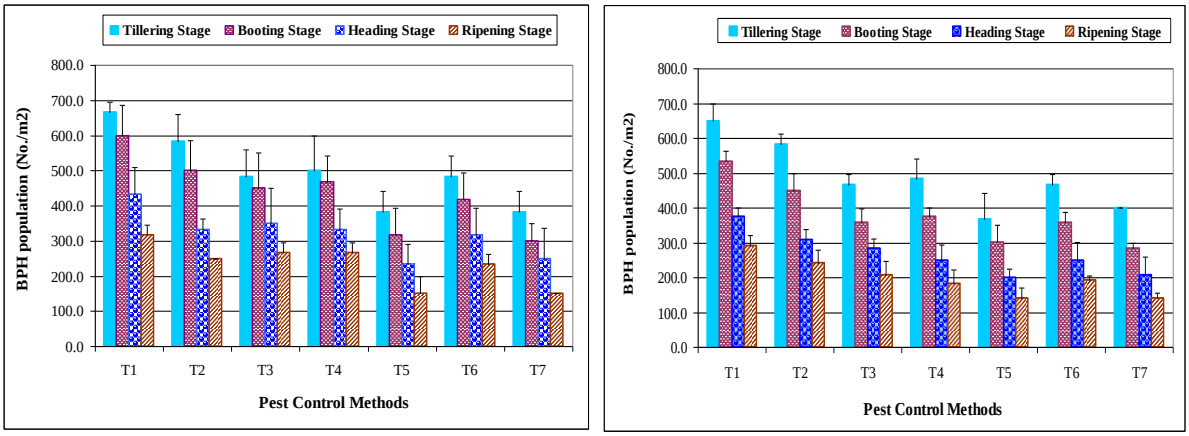
Effect of pest control methods on Brown Plant Hopper population

The results presented in Figure 1 show that among the pest control treatments, the combination of chemical pesticides and bio-insecticides resulted in lower BPH population and tended to maintain the sustainability of effective prevention at all stages of rice growth in both DS 2011-2012 and WS 2012. The population of BPH was significantly different between T1 and T2, both using the same farmer management practice of broadcast seeding at 200 kg/ha and fertilized at 120-60-48 kg N-P_2O_5-K_2O/ha (DS), 100-60-50 kg N-P_2O_5-K_2O/ha (WS), but differing by the addition of bio-pesticides in T2. Among the five treatments (T3, T4, T5, T6 and T7) that applied row seeding at 120 kg/ha and fertilized according to the recommendation of 100-40-40 kg N-P_2O_5-K_2O/ha (DS) and 80-50-50 kg N - P_2O_5 - K_2O/ha (WS), the BPH populations were significantly different from T1 and T2 treatments. Equally effective control was obtained with T3 treatment (only bio-insecticides), T4 (application of IPM) and T6 (spraying chemical pesticides when the insect threshold was reached). However T5 and T7 gave the highest control of BPH populations and maintained sustainability during the growing season.

The percentage of damaged rice leaves by leaf folder

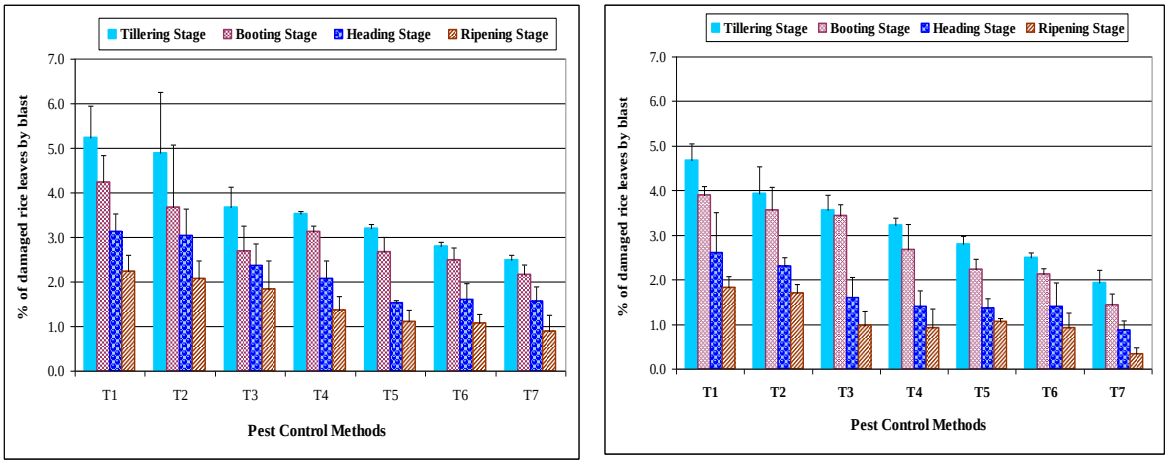
Among the pest control treatments**,** the combination of chemical pesticides and bio-insecticides resulted in a lower percentage of damaged rice leaves by leaf folder and tended to maintain the sustainability of effective control at all stages of rice growth. There were some variations in the percentage of damaged rice leaves by leaf folder between T1 and T2, but differences were only significant at the tillering stage in WS 2012. Both treatments were grown using farmers' practices but differed in the addition of bio-pesticides in T2 (Figure 2). All five treatments that applied recommended practices of row seeding at 120 kg/ha and fertilized according to the recommendation of 100-40-40 kg N-P_2O_5-K_2O/ha (DS) and 80-50-50 kg N - P_2O_5 - K_2O/ha (WS), resulted in significant

differences in the percentage of damaged rice leaves by leaf folder compared with T1 and T2 treatments. The T3 treatment only used bio-insecticides Silsau 1.8 EC and Proclaim 1.8 EC for specific control of leaf folder; T4 applied IPM techniques, and T6 sprayed chemical pesticides when the threshold was reached. All resulted in a reduction of the percentage of leaves damaged by leaf folder. Especially T5 and T7 resulted in the lowest percentage of damaged rice leaves, from 3.3 to 10.1% damaged in DS 2011-2012 and from 2.8 to 4.33% damaged in WS 2012. The other treatments varied from 3.6 to14.4% and from 3.83 to 7.9% damaged, respectively for DS and WS.



a. DS2011-2012 **b. WS2012**

Figure 1. Effect of pest control methods on BPH population in DS 2011-2012 and WS 2012 of OM 6976



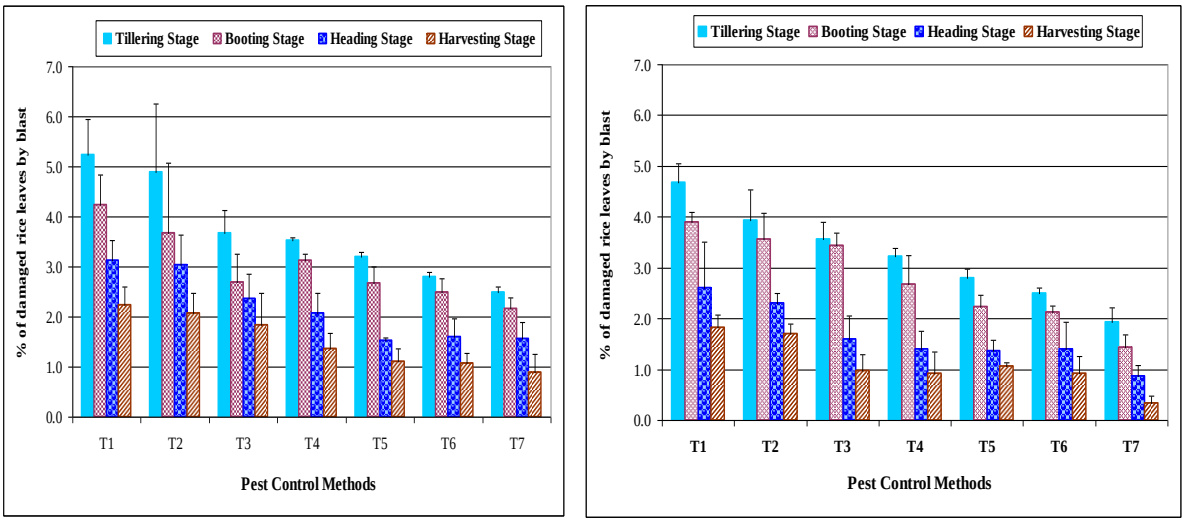
a. DS 2011-2012 **b. WS 2012**

Figure 2. Effect of pest control methods on percentage of damaged rice leaves by leaf folder in DS 2011-2012 and WS 2012.

The percentage of damaged rice leaves by blast

Blast quickly developed in cool weather conditions of the dry season, and in the WS 2012, for treatments of T1 and T2 that applied the farmer management practices with broadcast seeding of 200 kg/ha and high fertilizer rate, especially for nitrogen (120-60-50 kg N-P_2O_5-K_2O/ha) the percentage of damaged rice leaves

was not lower than in DS 2011-2012 (Figure 3). Two peaks of appearance of blast in the Mekong Delta occurred in May to June of WS and from November to December of DS that coincided with the periods of rice tillering. The percentage of rice leaves damaged by blast was lower in both seasons for pest control treatments that applied IPM and sprayed pesticides when the threshold was reached. Special fungicides for blast, Filia 525EC and Bump 650WP were used, so the damage was very low at ripening stages for all the treatments.



a. DS 2011-2012 **b. WS 2012**

Figure 3. Effect of pest control methods on percentage of damaged rice leaves by Blast in DS 2011-2012 and WS 2012

Effect of pest control methods on grain yield

Table 2: Effect of pest control methods on yield components of OM6976 in DS2011-2012 and WS2012.

Treatments	DS2011-2012				WS2012			
	Pan/ m^2	Filled grain No./Pan	Unfilled grain (%)	Weight of 1,000 grains (gr)	Pan/ m^2	Filled grain No./Pan	Unfilled grain (%)	Weight of 1,000 grains (gr)
T1	461 a	56 d	18.8 a	27.5 b	466 a	44 c	23.7 a	27.3 c
T2	458 a	57 d	17.4 a	27.5 b	470 a	45 c	23.5 a	27.5 bc
T3	391 b	67 bc	15.6 b	27.7 ab	375 b	56 b	18.3 b	27.8 a
T4	390 b	70 ab	14.7 bc	27.8 a	377 b	58 a	18.2 b	27.5 bc
T5	398 b	70 ab	14.5 bc	27.6 ab	381 b	59 a	17.2 bc	27.6 ab
T6	391 b	69 abc	13.4 cd	27.5 b	384 b	58 a	18.1 b	27.7 ab
T7	389 b	71 a	12.8 d	27.5 b	386 b	59 a	16.7 c	27.6 ab
F	**	**	**	Ns	**	**	**	*
CV%	11.9	12.4	15.3	2.5	7.6	11.8	13.0	2.5

*Values followed by the same letters are not significant difference at 5% level within treatments by DMRT; ^{ns} non- significant at 0.05; * significant at 0.05 and ** significant at 0.01*

The results presented in Figure 4 show that the yield of OM6976 in treatment T1 was the lowest of all treatments in both seasons of DS 2011-2012 and WS 2012. This was due to lower numbers of filled grain per panicle and a higher percentage of unfilled grain, compared with the other treatments which applied Recommended Management Practices and used IPM + bio-insecticides in pest control. Although treatment T3 got more filled grains per panicle and a lower percentage of unfilled grain, its yield was the same compared to the T1 and T2 treatments (Table 2). Treatments T5 and T7 attained greatest efficacy: the yields were 7.22 t/ha and 7.15 t/ha in DS 2011 -2012 and 5.72 - 5.67 t/ ha in WS 2012, respectively. These results also demonstrated that environmental improvement was very important in rice fields and that these pest control measures helped to achieve high economic and environmental efficiency for sustainable rice cultivation.

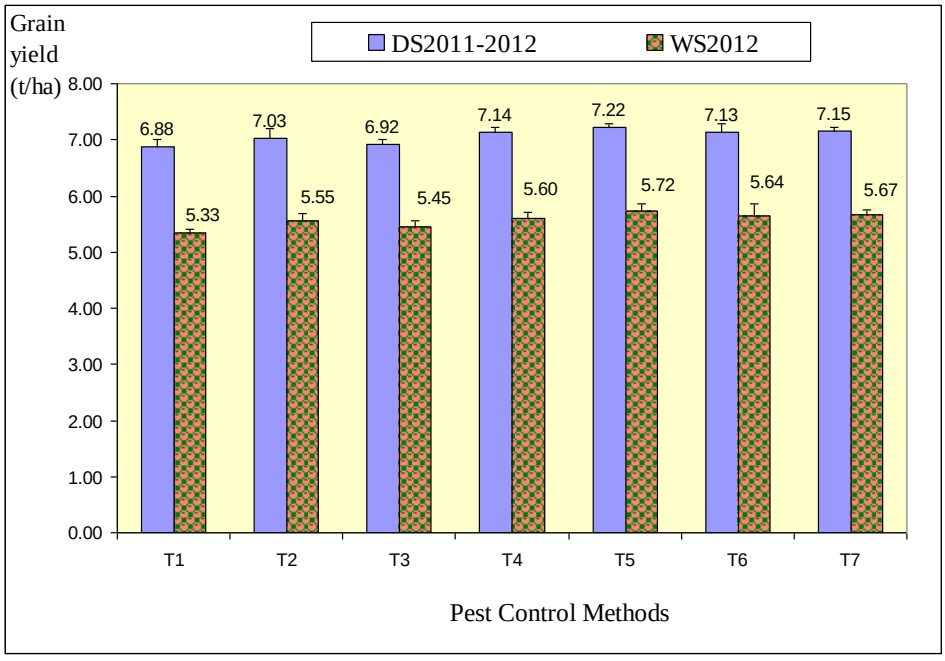


Figure 4. Effect of pest control methods on grain yield of OM 6976 in DS 2011-2012 and WS 2012

Effect of pest control methods on economic efficiency

The difference in profit among the pest control methods was quite large. The net benefit was highest in T5 (the IPM + bio-insecticides) compared with the Farmers' Practices and pest management by only using chemical pesticides (T1). It was greater by 5.19 million VND/ha (DS 2011 -2012) and 4.81 million VND/ ha (WS 2012). The next most profitable treatment was chemical spraying when reach the threshold combined with use of bio- insecticides (T7), with a net benefit greater by 4.61 million VND/ ha in DS 2011 -2012 and 4.49 million VND/ ha in WS 2012 compared with T1. These treatments reduced the amount of chemical pesticides by using partly or completely bio-insecticides such as Ometar, to control BPH and leaf folder, and consequently helped to educe pesticide costs significantly. Treatment T3 that used only bio- insecticides had the lowest cost of pest control and lowest total cost but did not get a high yield, so the difference in profit was also not high. The remaining treatments T4, T5, T6 and T7 got profits greater than T1 ranging from 4.47 to 5.19 million VND/ ha in DS 2011-2012 and from 4.02 to 4.81 million VND/ha in WS 2012. Compared to T2, profits were greater by from 2.65 to 4.03 million VND/ ha (Table 3

and 4). Thus, the treatments using IPM combined with bio- insecticides; and spraying chemicals when the threshold is reached combined with Bio-insecticides in pest control both help to achieve sustainable rice production and to meet VietGAP standards and protect producers, consumers and the environment. These two pest control methods produce sustainable efficiency through the harmony of economic and environmental benefits.

Table 3. Economic efficiency of pest control methods in DS 2011-2012 at Chau Dien commune, Cau Ke district, Tra Vinh province ***Unit: 1,000 VND/ha***

Parameters	**Pest Control Methods**						
	T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**
Grain yield (t/ha)	6.88	7.03	6.92	7.14	7.22	7.13	7.15
Gross benefit*	46,110	47,080	46,364	47,816	48,396	47,739	47,883
Seed cost *	2,900	2,900	1,740	1,40	1,740	1,740	1,740
Fertilizer cost*	5,151	5,151	4,042	4,042	4,042	4,042	4,042
Pesticide cost	4,320	4,130	3,132	3,822	3,682	3,432	3,752
Irrigation cost	1,700	1,700	1,700	1,700	1,700	1,700	1,700
Labor cost	8,000	8,000	8,000	8,000	8,000	8,000	8,000
Total cost	22,071	21,881	18,614	19,304	19,164	18,914	19,234
Production price *(VND/kg rice)*	3,207	3,114	2,690	2,705	2,653	2,655	2,691
Net benefit	24,039	25,199	27,750	28,511	29,232	28,824	28,648
Difference in Net benefit - Compared with T1	-	1,160	3,711	4,472	5,193	4,785	4,609
- Compared with T2	-	-	2,551	3,313	4,033	3,626	3,450

** Price of selling rice = 6,700 VND/kg; price of rice pure seed = 14,500 VND/kg; urea =10,000 VND/kg; super phosphate = 4,000 VND/ha; KCl= 13,000 VND/kg.*

Table 4. Economic efficiency of pest control methods in WS 2012 at Chau Dien commune, Cau Ke district, Tra Vinh province ***Unit: 1,000 VND/ha***

	Pest Control Methods						
	T1	T2	T3	T4	T5	T6	T7
Grain yield (t/ha)	5.33	5.55	5.45	5.60	5.72	5.64	5.67
Gross benefit*	28,782	29,970	29,430	30,258	30,906	30,438	30,600
Seed cost *	2,900	2,900	1,740	1,740	1,740	1,740	1,740
Fertilizer cost*	5,086	5,086	4,336	4,336	4,336	4,336	4,336
Pesticide cost	4,780	4,590	3,372	4,142	4,002	3,992	4,022
Irrigation cost	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Labor cost	8,000	8,000	8,000	8,000	8,000	8,000	8,000
Total cost	22,266	22,076	18,948	19,718	19,578	19,568	19,598
Production price *(VND/kg rice)*	4,177	3,978	3,477	3,519	3,421	3,472	3,458
Net benefit	6,516	7,894	10,483	10,540	11,328	10,870	11,002
Difference in Net benefit - Compared with T1	-	1,378	3,966	4,024	4,812	4,354	4,486
- Compared with T2	-	-	2,588	2,646	3,434	2,976	3,108

**Price of selling rice = 5,400 VND/kg; Price of rice pure seed =14,500 VND/kg; Urea =10,000 VND/kg; Super Phosphate = 4,000 VND/ha; KCl= 13,000 VND/kg.*

CONCLUSION

The two treatments that (1) applied IPM combined with bio-insecticides and (2) sprayed chemicals when the threshold was reached combined with use of bio-insecticides helped to achieve high economic and environmental efficiency of sustainable rice production and to meet VietGAP standards. Farmers attained increased net benefits of 4.61 million VND/ ha and 5.19 million VND/ha in DS 2011 -2012 and of 4.49 million VND/ ha and 4.81 million VND/ ha in WS 2012 compared with farmers' practices only using chemical pesticides.

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TÓM TẮT

Ảnh hưởng của các biện pháp quản lý sâu bệnh trong sản xuất lúa an toàn theo hướng hữu cơ sinh học ở tỉnh Trà Vinh

Nghiên cứu các biện pháp quản lý sâu bệnh trong sản xuất lúa an toàn theo hướng hữu cơ sinh học được thực hiện tại xã Châu Điền, huyện Cầu Kè tỉnh Trà Vinh trong 2 vụ ĐX2011-2012 và HT2012 với 7 nghiệm thức có sự kết hợp giữa biện pháp canh tác, quản lý sâu bệnh tổng hợp (IPM), sử dụng thuốc bảo vệ thực vật hóa học theo nông dân hoặc sử dụng thuốc BVTV hóa học khi tới ngưỡng, có hoặc không có kết hợp với thuốc trừ sâu sinh học. Hai nghiệm thức: (i) Quản lý sâu bệnh theo IPM kết hợp với thuốc trừ sâu rầy sinh học và (ii) sử dụng thuốc BVTV hóa học khi tới ngưỡng kết hợp với thuốc trừ sâu rầy sinh học đạt hiệu quả cao nhất trong phòng trừ sâu bệnh và hiệu quả kinh tế. Mật số rầy nâu, tỉ lệ lá bị hại do sâu cuốn lá, tỉ lệ lá bị bệnh cháy lá ở các giai đoạn sinh trưởng đều thấp và khác biệt có ý nghĩa so với các biện pháp quản lý sâu bệnh khác. Lợi nhuận gia tăng ở hai biện pháp quản lý sâu bệnh này cao hơn 4,61 triệu đồng/ ha và 5,19 triệu đồng/ ha trong vụ ĐX2011 -2012 và đạt 4,49 triệu đồng/ ha đến 4,81 triệu đồng/ ha trong vụ HT2012 so với biện pháp canh tác và phòng trừ sâu bệnh theo nông dân hoàn toàn bằng thuốc BVTV hóa học.