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Effect of 30% Tiange Multifunctional Pesticide-Fertilizer on Sugarcane Pests and Yield

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Abstract In order to study the effect of 30% Tiange multifunctional pesticide-fertilizer on sugarcane pests and sugarcane yield, the field test was conducted with conventional compound fertilizer and 3% carbofuran fertilizer granules as control. The results showed that 30% Tiange multifunctional pesticide-fertilizer could effectively suppress some pests such as sugarcane borer, thrip, aphid and cockchafer. 90 d after pesticide-fertilizer application, the sugarcane withered heart rate was 1.55% and 2.55% in the two test points, respectively, significantly lower than the rate of 15.40% and 19.40% under control. Before harvest, the sugarcane borer damage rate in the two test points under pesticide-fertilizer treatment was 8.70% and 9.47%, respectively, significantly lower than the rate of 34.50% and 33.50% under control, and the sugarcane yield was 21.16% and 22.14% higher than under control, respectively. 30% Tiange multifunctional pesticide-fertilizer had nutritional and insecticidal effect, which could help to achieve sugarcane pesticide-fertilizer integration and save labor and costs.

Key words 30% Tiange, Pesticide-fertilizer integration, Sugarcane pests, Control effect, Yield

1 Introduction

Sugarcane is the most important sugar crop and energy crop, and China is the third largest sugarcane producing country in the world^[1]. Pests are major factors affecting China's sugarcane yield and quality, including overground pests and underground pests^[2]. Pesticide-fertilizer integration avoids counteraction between pesticides and fertilizers, so that both pesticides and fertilizers are used during the optimal application period, thereby enhancing the fertilizer and pesticide effect^[3-4]. Over the years, researchers have been trying to mix herbicides, insecticides or fungicides with fertilizers into pesticide-fertilizer, so as to achieve fertilizing, weeding, insecticidal and fungicidal effects and save labor and costs through one-time field operation^[5]. The 30% compound sugarcane pesticide-fertilizer is developed by Yang Junxian *et al.* and years of field tests show that the control effect on sugarcane borer reaches 75.57% to 90.08%, and the yield increases by 16.44% to 23.58%, with significant effect^[6]. The 29% compound insecticide-fertilizer is developed by Zhou Jianqun *et al.*, and the control effect on sugarcane cockchafer reaches 76.33%, an increase of 24.87% in yield compared with the control treatment^[7]. The 30% NB special pesticidal compound fertilizer developed by Tang Hongqin *et al.* has good control effect on sugarcane borer, and can significantly improve sugarcane production and economic efficiency^[8]. The control effect of 0.06% clothianidin pesticide-fertilizer

mixture developed by Tang Jing *et al.* on sugarcane borer reaches as high as 86.80% to 92.95%^[9]. The control effect of 0.3% phoxim granules developed by Luo Yingyi *et al.* on sugarcane cockchafer reaches 86.03%, and this pesticide-fertilizer is safe to sugarcane and has no effect on natural enemy to sugarcane pests^[10]. The 0.05% dinotefuran pesticide-fertilizer mixture developed by Wang Shuang *et al.* has good control effect on sugarcane borer and thrip^[11]. Currently, the sugarcane planting is mostly in accordance with traditional separated application of fertilizers and pesticides, with randomness and blindness, and some pesticide-fertilizer products circulated on the market do not control both overground and underground pests. This study aimed to explore the effect of 30% Tiange multifunctional pesticide-fertilizer on sugarcane pests and sugarcane yield, in order to provide a basis for the official registration and application of such pesticide-fertilizer.

2 Materials and methods

2.1 Test materials and test points The test sugarcane variety was Yuetang 60 (Yuetang 03-393), new sugarcane. The test fertilizers and pesticides included 30% Tiange multifunctional pesticide-fertilizer (N:P₂O₅:K₂O = 12:6:12, developed by Zhanjiang Sugarcane Research Center of Guangzhou Sugarcane Industry Research Institute), 45% Yangfeng compound fertilizer (N:P₂O₅:K₂O = 15:15:15, produced by Hubei Xinyangfeng Fertilizer Industry Co., Ltd.), and 3% carbofuran granules (produced by US FMC Corporation). The test was carried out in Xinqiao test point (Suixi County, Zhanjiang City, Guangdong Province) and Nanguang test point (Leizhou City, Zhanjiang City, Guangdong Province) in 2014, respectively. In Xinqiao test point, the soil was lateritic soil, terrain was relatively flat and soil fertility was at medium lev-

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el. There were irrigation conditions, and sugarcane was planted on the land every year; in Nanguang test point, the soil was red clay, terrain was flat and soil fertility was at medium level. There were irrigation conditions, and sugarcane was planted on the land every year. The two plots were the plots with serious sugarcane pests over the years.

2.2 Experimental design (i) During seeding (February 15, 2014), 600 kg/ha 30% Tiange multifunctional pesticide-fertilizer was applied in the furrow; during earthing-up (June 15, 2014), 1500 kg/ha pesticide-fertilizer was applied in the furrow. (ii) As for the control treatment, during seeding (February 15, 2014), 375 kg/ha 45% Yangfeng compound fertilizer and 60 kg/ha 3% carbofuran granules were applied in the furrow; during earthing-up (June 15, 2014), 1500 kg/ha 45% Yangfeng compound fertilizer and 60 kg/ha 3% carbofuran granules were applied in the furrow, with a total of 2 treatments. The randomized block design was conducted, with four replications, spacing of 1.1 m and plot area of 200 m². The protection lines were set around the test area, and the planting density was 45000 double shoots per ha. Without applying additional fertilizer and pesticide in field management, other cultivation and management measures were used according to local conventional production methods.

2.3 Data investigation After the peak of the first generation borers occurred (April 2014), the seedlings with withered heart were investigated, and they were then investigated every 20 d until jointing, a total of three times, to calculate withered heart rate. When the sugarcane leaf pests broke out in July, 100 sugarcane plants were randomly investigated under each treatment, to calculate the number of plants damaged by sugarcane thrip as well as diseased plant rate and control effect. At the same time, 100 sugarcane plants were randomly investigated under each treatment, to calculate the number of plants damaged by sugarcane thrip as well as diseased plant rate and control effect. During harvesting in late December, 20 sugarcane plants were randomly selected under each treatment, and total number of sections and number of dis-

eased sections of each sugarcane plant were investigated, to calculate the borer damage rate. After sugarcane harvesting, three points were randomly selected in each plot, and the sugarcane head was dug in 1 m² ridge from each point, to investigate the number of residual sugarcane pests and calculate the growth rate of control effect. During growth and harvesting stage, the agronomic traits and yield were investigated and analyzed.

2.4 Calculation methods of pesticide effect According to the number of pests in different periods, the control effect was calculated and the method was based on GB/T17980.61-2004^[12].

2.5 Statistical analysis Microsoft Excel and DMRT were used for statistical analysis.

3 Results and analysis

3.1 Effect of 30% Tiange multifunctional pesticide-fertilizer on sugarcane borer The test results showed that 30% Tiange multifunctional pesticide-fertilizer had good control effect on sugarcane borer, and the effect lasted up to 3 months (Table 1). In Xinqiao test point, under 30% Tiange multifunctional pesticide-fertilizer treatment, the sugarcane withered heart rate was investigated three times to be 0.72%, 0.50% and 2.55%, respectively, significantly lower than under the control treatment (45% Yangfeng compound fertilizer + 3% carbofuran fertilizer granules) (4.25%, 6.28% and 15.40%). Before harvesting, the sugarcane borer damage rate was only 8.70% under pesticide-fertilizer treatment, significantly lower than under the control treatment (34.50%). In Nanguang test point, under 30% Tiange multifunctional pesticide-fertilizer treatment, the sugarcane withered heart rate and sugarcane borer damage rate before harvesting were investigated three times, significantly lower than under the control treatment (45% Yangfeng compound fertilizer + 3% carbofuran fertilizer granules), and the difference was significant ($p < 0.05$). The result was consistent with the result in Xinqiao test point.

Table 1 Control effect on sugarcane borer under different treatments in different points

Test point	Treatment	40 d withered heart rate//%	60 d withered heart rate//%	90 d withered heart rate//%	Borer damage rate//%
Xinqiao test point (Suixi County, Zhanjiang City)	30% Tiange pesticide-fertilizer	0.72 a	0.50 a	2.55 a	8.70 a
	45% Yangfeng compound fertilizer + 3% carbofuran fertilizer granules	4.25 b	6.28 b	15.40 b	34.50 b
Nanguang test point (Leizhou City, Zhanjiang City)	30% Tiange pesticide-fertilizer	0.85 a	1.20 a	1.55 a	9.47 a
	45% Yangfeng compound fertilizer + 3% carbofuran fertilizer granules	5.80 b	12.90 b	19.40 b	33.50 b

Note: Different lower case letters behind the same column of control effect data indicated a significant difference at the 0.05 level.

3.2 Effect of 30% Tiange multifunctional pesticide-fertilizer on sugarcane leaf pests As shown in Table 2, 30% Tiange multifunctional pesticide-fertilizer had good control effect on sugarcane thrip and aphid in the two test points. The test results in Xinqiao test point showed that the control effect on sugarcane thrip under

30% Tiange multifunctional pesticide-fertilizer treatment was 89.60% higher than under the control treatment (45% Yangfeng compound fertilizer + 3% carbofuran fertilizer granules), and the control effect on sugarcane aphid was 97.15% higher than under the control treatment. The test results in Nanguang test point

showed that the control effect on sugarcane thrip under 30% Tiange pesticide-fertilizer treatment was 92.79% higher than un-

der the control treatment, while the control effect on sugarcane aphid was 100.00% higher than under the control treatment.

Table 2 Control effect on sugarcane leaf pests under different treatments in different points

Test point	Treatment	Sugarcane thrip		Sugarcane aphid	
		Diseased plant rate//%	Control effect//%	Diseased plant rate//%	Control effect//%
Xinqiao test point (Suixi County, Zhanjiang City)	30% Tiange pesticide-fertilizer	2.1	89.06	0.45	97.15
	45% Yangfeng compound fertilizer + 3% carbofuran fertilizer granules	19.2	0.00	15.80	0.00
Nanguang test point (Leizhou City, Zhanjiang City)	30% Tiange pesticide-fertilizer	1.7	92.97	0.00	100.00
	45% Yangfeng compound fertilizer + 3% carbofuran fertilizer granules	24.2	0.00	14.20	0.00

3.3 Effect of 30% Tiange multifunctional pesticide-fertilizer on sugarcane cockchafer

As shown in Table 3, the control effect on sugarcane cockchafer under 30% Tiange multifunctional pesticide-fertilizer treatment in the two points was 84.41% and 87.50% higher than under the control treatment (45% Yangfeng

compound fertilizer + 3% carbofuran fertilizer granules), respectively, and the results showed that 30% Tiange multifunctional pesticide-fertilizer had significant control effect on sugarcane cockchafer.

Table 3 Control effect on underground pests under different treatments in different points

Test point	Treatment	Cockchafer	
		Residual population//m ²	Control effect//%
Xinqiao test point (Suixi County, Zhanjiang City)	30% Tiange pesticide-fertilizer	0.36	84.41
	45% Yangfeng compound fertilizer + 3% carbofuran fertilizer granules	2.31	0.00
Nanguang test point (Leizhou City, Zhanjiang City)	30% Tiange pesticide-fertilizer	0.45	87.50
	45% Yangfeng compound fertilizer + 3% carbofuran fertilizer granules	3.60	0.00

3.4 Effect of 30% Tiange multifunctional pesticide-fertilizer on economic characters and yield of sugarcane

As shown in Table 4, in Xinqiao test point, compared with the control treatment (45% Yangfeng compound fertilizer + 3% carbofuran fertilizer granules), the average sugarcane height increased by 15.0 cm, the average stem diameter increased by 0.14 cm, the average stem weight increased by 0.26 kg per plant, the average number of effective stem increased by 9150 per ha, and sugarcane yield increased by 18900 kg/ha under 30% Tiange multifunctional pesti-

cide-fertilizer treatment. The differences in sugarcane yield between 30% Tiange multifunctional pesticide-fertilizer treatment and control treatment reached a significant level ($p < 0.05$). In Nanguang test point, compared with control treatment, the sugarcane plant height, stem diameter, stem weight and number of effective stem significantly increased under pesticide-fertilizer treatment, and sugarcane yield increased by 21.16%, with a significant difference ($p < 0.05$). The result was consistent with that in Xinqiao test point.

Table 4 Effect on economic characters and yield of sugarcane

Test point	Treatment	Plant height//cm	Stem diameter//cm	Stem weight per plant//kg	Number of effective stem//ha	Yield kg/ha	Relative increase rate//%
Xinqiao test point (Suixi County, Zhanjiang City)	30% Tiange pesticide-fertilizer	285.8	2.85	1.82	66900	104250a	22.14
	45% Yangfeng compound fertilizer + 3% carbofuran fertilizer granules	270.8	2.71	1.56	57750	85350b	0.00
Nanguang test point (Leizhou City, Zhanjiang City)	30% Tiange pesticide-fertilizer	280.1	2.9	1.85	65100	97050a	21.16
	45% Yangfeng compound fertilizer + 3% carbofuran fertilizer granules	272.8	2.78	1.51	56250	80100b	0.00

Note: Different lower case letters behind the same column of control effect data indicated a significant difference at the 0.05 level.

3.5 Effect of 30% Tiange multifunctional pesticide-fertilizer on economic benefits of sugarcane

As shown in Table 5, in

terms of agricultural economic benefits, based on the purchasing price (400 yuan/t) of sugarcane raw material, the average agri-

cultural output value in the two test points by applying 30% Tiange multifunctional pesticide-fertilizer was 38820.0 and 41700.0

yuan/ha, respectively, increasing by 6780.0 and 7560.0 yuan/ha compared with the control treatment, respectively.

Table 5 Effect on economic benefits of sugarcane

Test point	Treatment	Sugarcane yield kg/ ha	Output value yuan/ha	Income increase yuan/ha
Xinqiao test point (Suixi County, Zhanjiang City)	30% Tiange pesticide-fertilizer	104250	41700.0	7560.0
	45% Yangfeng compound fertilizer + 3% carbofuran fertilizer granules	85350	34140.0	0
Nanguang test point (Leizhou City, Zhanjiang City)	30% Tiange pesticide-fertilizer	97050	38820.0	6780.0
	45% Yangfeng compound fertilizer + 3% carbofuran fertilizer granules	80100	32040.0	0

4 Conclusions and discussions

In this paper, the test was conducted with conventional compound fertilizer and 3% carbofuran fertilizer granules as control to study the effect of 30% Tiange multifunctional pesticide-fertilizer on sugarcane pests and sugarcane yield. The results showed that 30% Tiange multifunctional pesticide-fertilizer could effectively suppress some pests such as sugarcane borer, thrip, aphid and cockchafer. 90 d after pesticide-fertilizer application, the sugarcane withered heart rate was 1.55% and 2.55% in the two test points, respectively, significantly lower than the rate of 15.40% and 19.40% under control. Before harvest, the sugarcane borer damage rate in the two test points under pesticide-fertilizer treatment was 8.70% and 9.47%, respectively, significantly lower than the rate of 34.50% and 33.50% under control, and the sugarcane yield was 21.16% and 22.14% higher than under control, respectively. 30% Tiange multifunctional slow-release pesticide-fertilizer had remarkable insecticidal effect and scientific formulation, without additional application of any fertilizers and pesticides, thereby saving labor and costs, increasing production and income. It was safe to human and ecological environment, and could replace the traditional application mode of conventional fertilizers and pesticides. The active pesticide ingredient in 30% Tiange multifunctional pesticide-fertilizer was the combination of monosultap and chlorpyrifos which could effectively control overground and underground sugarcane pests, and had obvious control effect on sugarcane borer, thrip, aphid and cockchafer, which was consistent with the previous report^[13-15]. This study provided a solid scientific basis and experimental basis for the reporting, registration and promotion of 30% Tiange multifunctional pesticide-fertilizer.

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