Studies on control of stored grain pests with botanical grain protectant Anlianxian

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Abstract
Botanical grain protectant Anlianxian was composed of Chinese herbal medicines and chemical insecticides. Studies showed that No. 1 Anhanxian had the best effectiveness for control of the main stored grain pest insects, such as Sitophilus zeamais (Motschulsky), Rhizopertha dominica and Cryptolestes existing in the stored wheat and paddy. After 7 months, in treated wheat the total number of insect pests inspected decreased 97.3% compared with that of control. Reduced 96.9% compared with 0.04% Guchongjmg treatment. Control effectiveness of No. 1 Anhanxian amounted to 96.9%. Paddy treated with No. 1 Anhanxian, the number of insect pests were less than 5 heads/2 hrs (inspected by trapping method) for 9 months. After 10 months damaged rate of paddy treated was 0.5% and control effectiveness came up to 96.9%.

Introduction
For a long period Chemical grain protectants have mainly been used for controlling stored grain insect pests in China and abroad, retrieving a lot of losses. But three serious problems of pesticide residue, insect resistance to insecticides and insect re-rampancy arose because of its application for a long time. So far as the pest resistance to insecticides was concerned, it was reported that about 10% stored grain pest strains were resistant to hydrogen phosphide all over the world. In our country the main stored grain insect pests, such as Sitophilus zeamais, Sitophilus oryzae, Rhizopertha dominica, Tribolium Castaneum, Tribolium confusum and Cryptolestes pusillus, etc., all produced different levels of resistance to malathion, hydrogen phosphide and gamma-BHC. In few districts the index of resistance to phosphine amounted to 1000 times. It followed that exploring new approaches and methods become an urgent task.

Since the 1970s the studies on botanical pesticides by scholars in China and abroad has become an active field. The study results of botanical pesticides were reported in some foreign countries, such as the United States, Sudan, Australia, Cameroon, Colombia, India, West Germany, Nigeria, Pakistan, etc. Since the 1980s Zhao Shanhuan, Yao Kang et al. in our country studied the control of the stored grain pests with botanical materials, achieving encouraging progress. On the basis of predecessors achievements we made a lot of studies on controlling the stored grain pests with botanical materials in the laboratory from June, 1994 to June, 1995, developing the botanical grain protectants of Anlianxian series. In order to spread and apply this protectant, field trials were conducted in warehouses from July, 1995 to September, 1996. The results were as the following.

Material and Methods
From July 4, 1995 to Feb 13, 1996 expended experiments were conducted with new harvested wheat at warehouses of Shiyang Grain Depot in Jiimen City, Hubei Province. Moisture of grain was 12.5%.
From Oct. 14, 1995 to Sept. 15, 1996 field trials were conducted with new harvested middle-season indica paddy at experiment warehouses of Shih grain administrative office in Jiimen City, Hubei Province. Moisture of grain was 13.6%.
Botanical protectants used for treating new wheat were powder of No. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11 Anhanxian. The constituents (W/W) of No. 1 Anhanxian were Alpinia officinarum Hance 10.0%, Artemisia argyi Levl. et. Vant 40.0%, deltamethrin 0.01% (A. I.) with 0.1% PB and fenitrothion 0.49% (A. I.); No. 2 Anhanxian were Cinnamomum louweiri Nees 10.0%, A. Argyi 40.0% and fenitrothion 0.49% (A. I.); No. 3 Anhanxian were A. officinarum 10.0%, tangerine peel 40.0% and fenitrothion 0.49% (A. I.); No. 4 Anhanxian were A. officinarum 10.0%, tangerine peel 40.0% and fenitrothion 0.49% (A. I.); No. 5 Anhanxian were A. officinarum 10.0%, tangerine peel 40.0% and fenitrothion 0.49% (A. I.); No. 6 Anhanxian were A. officinarum 10.0%, A. Argyi 40.0% and deltamethrin 0.02% (A. I.) with 0.2% PB; No. 7 Anhanxian were A. officinarum 10.0%.
tangerine peel 40.0% and deltamethrin 0.02% (A. I.) with 0.2% PB; No.7 Anhanxian were A. officinarum 10.0%, A. argyi 40.0% and fenpropath 0.49% (A. I.); No.8 Anhanxian were A. officinarum 10.0%, A. argyi 40.0%, tangerine peel 40.0% and fenpropath 0.49% (A. I.); No.9 Anhanxian were C. louveirii 10.0%, A. argyi 40.0% and malathion 0.049% (A. I.); No.10 Anhanxian were A. officinarum 10.0%, A. argyi 40.0% and deltamethrin 0.005% (A. I.) with 0.05% PB Anhanxian were A. officinarum 10.0%, A. argyi 40.0%, and deltamethrin 0.02% (A. I.) with 0.2% PB and No.11 Anhanxian were C. louveirii 10.0%, tangerine peel 40.0% and deltamethrin 0.01% (A. I.) with 0.1% PB. For every treatment was in two duplicates and 50 kg of wheat and 50g of Anhanxian were used. After thoroughly mixed, wheat was loaded into plastic film lining woven bag, and randomly placed in the warehouse, with the bags open and the stored grain pests infesting freely. At same time, the treatments of 0.5 ppm (A. I.) deltamethrin with 5ppm PB, 8ppm(A. I.) fenpropath, 10ppm(A. I.) malathion and 0.04% Guchongjing were also set up as controls.

Fig. 1A. After 7 months total number of insect pests (Treated from July 4, 1995 to Feb. 23, 1996 at Shayang Gran Depot).

Fig. 1B. After 7 months damage of wheat (%) (Treated from July 4, 1995 to Feb 23, 1996 at Shayang Gran Depot).

Note: K-DELTAMETHRIN F-Fenpropath M-Malathion A-Anhanxian series G-0.04% Guchongjing
For treating new harvested middle-season indica paddy, same dosages of No. 1, 2, 3 and 4 Anhanxian were used. With 1 kg Anhanxian mixed with 1000 kg grain Every treatment was in 2 duplicates and 3000 kg of paddy were used. At the same time the controls were also set up. The conventional method was used for storing the paddy.

At the beginning and end of the experiments or trails, the moisture content of grain, the insect variety and density, and the damage rate of grain were inspected.

The temperature and the relative humidity in warehouse, grain temperature, insect variety and its density were inspected weekly. The inspections of stored grain insects were conducted with a probe trap made in Shanxi institute of zoology and each inspection took two hours. The damage rate of grain was checked monthly.

### Results and Analysis

#### Results of Anlianxian Series wheat treatment

The cumulative insect pest number of 33 inspections during the experiments and the damaged rate of wheat at the end of the experiments were drawn in Figure 1A and Figure 1B.

In the 223-day period of experiments the largest number of insect pests trapped in the control was 50 heads/2 hrs, and the number under 5 heads/2 hrs was 6 times, accounting for 18.1% of the total 33 inspections, above 10 heads/2 hrs was 24 times, accounting for 72.7%. The cumulative number of insect pests for 33 inspections was 653.5 heads. In 0.04% Guchongjing treatments the maximum number of insect pests trapped was 46 heads/2 hours. The number below 5 heads/2 hrs was 9 times, accounting for 27.2% of the total. Beyond 10 heads/2 hours was 21 times, accounting for 63.6%. The cumulative number of insect pests for 33 times was 572.5 heads. In wheat treated with No. 1, 3, 4, 5, 6, 7, 8, 9, 10, 11 Anhanxian, deltamethrin, fenitrothion and malathion except one time the number of insect pests more than 5 head/2hrs for 0.5 ppm Deltamethrin (18 heads/hrs), No. 6 Anlianxian (7.5 heads/2 hrs), No. 7 Anhanxian (11.5 heads/2 hours), No. 3 Anhanxian (10 heads/2 hours), No. 10 Anhanxian (6 heads/2 hours) and No. 11 Anhanxian (5.5 heads/2 hours) respectively. The number of insects trapped all was lower than 5 heads/2hrs. The total number of insect pests trapped for 33 times was only 17.5 - 56 heads. Decreased 91.4 - 97.3% compared with that of the control and reduced 90.2 - 96.9% in comparison to that of 0.04% Guchongjing treatments. The insect pests trapped were Sitophilus zeamais first, then Tribolium castaneum and Cryptolestes.

After 7 months, the damaged rate of wheat for control was up to 79.5%, for 0.04% Guchongjing treatment was 58.5% while the damaged rate of wheat treated with Anhanxian Series protectants and other chemical protectants were only 1.0 - 4.0%. There seems no obvious difference occurred in the total number of insect pests and the damaged rate of wheat treated with Anhanxian series, 0.5 ppm Deltamethrin, 8 ppm fenitrothion and 10 ppm malathion. Provided that the damaged rate reduction of wheat was used as reference index evaluating the control effect, the wheat treated with Anhanxian Series came up to 94.9 - 98.7%, achieving the same control effects of 0.5 ppm deltamethrin, 8 ppm fenitrothion and 10 ppm malathion. At the same time the control effect of 0.04% Guchongjing treatment was only 26.4%.

#### Results of Anlianxian Series treating paddy

The grain temperature curves of various treatments during the field trials were drawn in Figure 2. And the curves of insect pest amount variations in each treatment bulk were shown in Figure 3.

From Figure 2 it could be seen that the grain temperatures were between 8.3 - 34.8°C in the field trail period, at the beginning stage the temperature of control was lower than that of treatments, but the next year it became higher than the treatments gradually.

As shown in the Fig 3, the number of insect pests (mainly including Sitophilus zeamais, Rhizopertha dominica and Cryptolestes) in control bulk was almost still much larger than that of treatments. In every trapping it was all over 10 heads/2 hrs. From the second ten days of April, 1996, the number of pests arose dramatically and after 10 months amounted to 556 heads/2 hrs. The damaged rate of grain accounted up 14.67%, with the result that the grain temperature arose obviously. On August 20 the controls were fumigated with aluminum phosphate.

In paddy treated with No. 1 Anhanxian the maximum number of insect pests was only 14.5 heads/2 hrs on August 23, 1996. The number of insect pests was below 5 heads/2 hrs for 9 months and the damaged rate of paddy was only 0.5% for 10 months, reaching 96.6% control effect. In paddy treated with No. 2 Anhanxian the maximum number of trapped insects was 34 heads/2 hrs. The number of insect pests was less than 5 heads/2 hrs for 8 months and the damaged rate of paddy was only 1.67%, attaining 88.6% control effect. In paddy treated with No. 3 and No. 4 Anhanxian the largest numbers of insect pests were 49.5 heads/2 hrs and 150.5 heads/2 hrs, respectively. The number of insect pests was below 10 heads/2 hrs for 8.5 months. It was also found from investigations that there were innumerable Psocids in the control bulk while the number of Psocids in treated paddy bulks was 82 - 376 heads/2 hrs. It followed that these botanical protectants also showed inhibition action on population formation of Psocids.

Comparing the four protectants for controlling Sitophilus zeamais, Rhizopertha dominica, and Cryptolestes, the order of control effect was No. 1 Anhanxian > No. 2 Anhanxian > No. 3 Anhanxian > No. 4 Anhanxian.
Fig. 2. Temperature variation plot of rice (treated at Shih Grain Distribution station in Jinmen City from Oct., 1995 to Sep., 1996).

Fig. 3. Number variation plot of pests in the rice barns (treated from Oct., 1995 to Sep., 1996)

Note: 1. The number of pests included Sitophilus oryzae, Rhyzopertha dominica and Cryptolestes, excluding the number of pyrethos.
2. As the population density in the control barn was too high, the control barn was fumigated and treated with aluminum phoshade on August 20, 1996.
Conclusion and Discussion

The expanded experiments and field trials have demonstrated that for controlling of stored grain insect pests No. 1 Anlianxian had the best effect. It could inhibit the population of *Sitophilus zeamais*, *Rhizopertha dominica* and *Cryptolestes* effectively. In the experiments of wheat during 7 months the total number of insect pests trapped was only 17.5 heads, decreasing 97.3% in comparison with the control and 96.9% compared with 0.04% Guchongjing treatment. In field trials of paddy the number of insect pests was below 5 heads /2 hrs for 9 months. The damaged rate of paddy was only 0.5%, and the control effect was 96.6% after 10 months.

The botanical grain protectant No. 1 Anlanxian is characteristic of cheap cost, safety to human and animals, no pollution to the stored grain and lasting control effectiveness. For these reasons, No. 1 Anlanxian is greatly worth popularising and applying.

For No. 5, 6, 7, 8, 9, 10, 11 Anlianxian, it is necessary to carry out the field trials so as to further demonstrate the control effectiveness.

References

