Causes of Recurrence of Rice Chilo suppressalis (Walker) in Longyou County and Prevention and Control Measures

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Abstract In recent years, the occurrence of rice Chilo suppressalis (Walker) in Longyou County of Zhejiang Province has increased year by year and has become aggravated. This poses a great threat to the safety of rice production. In order to curb the recurrence momentum of rice C. suppressalis, according to the dynamic monitoring and field system survey of rice C. suppressalis in Longyou County since 2015, the causes of the annual increase of rice C. suppressalis in recent years were analyzed, and the recurrence area of C. suppressalis was introduced, and finally some prevention and control measures were put forward.

Key words Chilo suppressalis (Walker), Causes of recurrence, Prevention and control measures

1 Introduction
Longyou County is located in the western area of Zhejiang Province, in the middle of the Jinqiu Basin. In recent years, the rice planting area of the whole Longyou county is about 21 333 ha. The area of early, middle and late rice varieties accounts for 24.6%, 48.6% and 26.8%, respectively. Thus, Longyou County is a typical single harvest and double harvest mixed planting area. Chilo suppressalis (Walker) is one of the main pests of rice in Longyou County, and it occurs 3 to 4 generations annually. After 2015, due to the long-term use of pesticides such as Chlorantraniliprole (C₈₅H₉₀BrCl₂N₂O₂), the level of resistance to C. suppressalis has increased significantly, combined with changes in rice varieties, evolution of farming systems, change in climatic conditions, etc. The base of C. suppressalis has rebounded significantly, and the damage has increased year by year. In 2017, the area of rice C. suppressalis was 44 667 ha, the area of control was 46 667 ha, the loss of rice in the field was 3% ~ 5%, and the loss of rice caused by serious field was greater than 20%. In view of this situation, we sorted the data of many years on the occurrence and control of rice C. suppressalis in Longyou County, analyzed the causes of the recurrence of rice C. suppressalis in recent years, and proposed a series of comprehensive prevention and control measures for C. suppressalis.

2 Causes of recurrence of Rice C. suppressalis in recent years
2.1 Great increase of the drug resistance, gradual increase of residual number after winter, significant increase in recent three years In recent years, the level of resistance to pesticides such as Chlorantraniliprole and other pesticides has increased significantly (in 2017, the inspection results of Longyou County indicated that the resistance of C. suppressalis to Chlorantraniliprole was up to 317.12 times) and the effect of warm winter, the residual number after winter increased year by year. According to the residual C. suppressalis number results of Longyou Station in Daling Village and Liangtang Village of Rashi Town, Wukan Village in Mohuan Township, Shilu in Douchuang Residential Area, Shandi Village and Houting Village in Longzhou Residential Area, Zhitang Village and Yaotang Village in Hengshan Town in April 16, 2018, the weighted average of the residual number of C. suppressalis after winter in the whole county was 2 297, 2 597, 3 636, and 5 256 heads in 667 m² land in 2014 ~ 2017, respectively. The residual number of C. suppressalis after winter was gradually increased, especially recent three years; in 2016 ~ 2018, the residual number of C. suppressalis after winter was 1.4 times, 2.02 times, and 2.42 times of that in 2015.

2.2 Large number of emerging moths in the winter generation, large moth peak number, and long moth peak day Due to increase in residual number after winter and high temperature in early spring, the number of emerging moths in wintering generation gradually increased, the moth peak number was large and moth peak day was long, leading to gradual aggravation of first generation C. suppressalis in early season rice. According to monitoring of C. suppressalis sex attractant system in Liuchu Village in Longzhou Residential Area, the quantity of wintering generation emerging moths trapped in 5 trays in peak day was 239 pieces in 2018, 195 pieces in 2017, and 90 pieces in 2016; the total moths of wintering generation emerging moths trapped in 5 trays was 3 768 pieces in 2018, 2 297 pieces in 2017, and 1 223 pieces in 2016. The number of days with more than 80 pieces of the wintering generation emerging moths trapped in 5 trays was 19 in 2018, 10 and 2 in 2017 and 2 in 2016, as shown in Fig. 1.

2.3 Long duration of the first and second generation of "medium moths" and extreme disuniform field state The duration of the first and second generation of "medium moths" in
emerging *C. suppressalis* (the number of moths daily trapped in 5 trays was 40–80 pieces) was long. According to monitoring of *C. suppressalis* sex attractant system in Liucun Village in Longzhou Residential Area, the average number of the first and second generation of emerging moths daily trapped in 5 trays was 39 and 30 pieces, respectively; the number of days for "medium moths" (the number of moths daily trapped in 5 trays was 40–80 pieces) was 23 and 7 d; the average number of the first and second generation of emerging moths daily trapped in 5 trays in 2017 was 27 and 7 pieces, respectively; the number of days for "medium moths" (the number of moths daily trapped in 5 trays was 40–80 pieces) was 4 and 0 d (Fig. 2 and Fig. 3); the state of moths in the field was extremely disuniform, the coexistence of moths, eggs, larvae and pupa was very common, so the difficulty in prevention and control was great (the comparison of field hazard peaks of *C. suppressalis* was illustrated in Fig. 5 to Fig. 7).

According to the survey of residual number after the treatment of the first and second generation of rice *C. suppressalis* in the field in 2018, the ratio of second, third, fourth, fifth and sixth years and pupa was 17:53:16:4:7:3; the survey of residual number after the treatment of the third generation of rice *C. suppressalis*, the the ratio of third, fourth, fifth and sixth years and pupa was 52:28:12:4:4.

2.4 Obvious tail peak of the first generation moths and high peak of the third generation of moths, and acceleration of generation process  Due to the influence of the warm winter and high temperature in early spring, the high peak of wintering moths in the year of 2018 was 15 days earlier than in 2017 (Fig. 1). In 2017 and 2018, the tail peak of the first generation moths of *C. suppressalis* was obvious in the early season rice, and the quantity of moths was larger than the front peak, and the tail peak mainly threatened the the single harvest paddy field in the single harvest and double harvest mixed area, and it had serious damage to the single harvest paddy field where only one time of prevention was carried out or it was no time for prevention and control (Fig. 7). In 2017 and 2018, *C. suppressalis* completed two complete generations in the early season rice (Fig. 2). In 2017, the high peak of third generation moths of *C. suppressalis* was obvious and in large quantity. The trend of continuous cropping late season rice finishing the fourth complete generation was obvious (Fig. 4). As a result, *C. suppressalis* caused serious damage to late season paddy field where no prevention and control measures were carried out or it was no time for prevention and control (Fig. 6).

2.5 Many varieties of rice, diversified cultivation methods, uneven growth period, many bridges and fields, and abundant hosts  According to the incomplete statistics of the Longyou County Seed Station, there are more than 50 varieties of rice planted in Longyou County in recent years. The rice varieties are complicated, the growth period is uneven, the bridge fields are increased, and the foods of *C. suppressalis* are rich. From late May to mid-September, there are almost all rice in the growth stage such as tillering stage and rupturing stage, which is very favorable.
for the spawning of imagos of *C. suppressalis* and larvae making irregular short tunnels in the rice stem. Besides, the promotion of thick-stem large panicle super rice varieties, diversification of cultivation methods, coexistence of single harvest and double harvest rice mixed planting, transplanting rice, direct seeding rice, shoot culture rice, and reclaimed rice further aggravated the occurrence and harm of *C. suppressalis*.

![Graph](image1.png)

**Fig. 5** Comparison of wave peaks of hazards of *Chilo suppressalis* to early season paddy field in 2016 – 2018

![Graph](image2.png)

**Fig. 6** Comparison of wave peaks of hazards of *Chilo suppressalis* to continuous cropping paddy field in 2015 – 2017

![Graph](image3.png)

**Fig. 7** Comparison of wave peaks of hazards of *Chilo suppressalis* to single harvest paddy field in 2015 – 2017

3 Prevention and control measures for *C. suppressalis*

3.1 Strengthening administrative promotion and implementing propaganda and technical training In 2017, Longyou County People's Government Office issued the *Notice on Implementing the Prevention and Control of *C. suppressalis* (Long Zheng Ban Fa[2017] No. 34)*, carried out the TV propaganda of *C. suppressalis* "pouring water to kill larvae", to strengthen the popularization of the technical measures of "pouring water to kill larvae" for *C. suppressalis*. In addition, Longyou County held trainings of comprehensive prevention and control technology for rice *C. suppressalis*. To further implement the key technical measures for comprehensive prevention and control of *C. suppressalis*.

3.2 Strengthening the dynamic monitoring of the occurrence of *C. suppressalis*, promptly providing warning and guidance for prevention and control On the basis of improving and standardizing the systematic observation of the observation site for *Chilo suppressalis* sex attractant in Liucun Village of Longzhou Residential Area and Wangjia Village of Hu Town, three new sets of Ningbo Newcom digital monitoring instruments and two sets of Beijing Ecoman remote control systems for remote control of *C. suppressalis*, to constantly improve the pest monitoring information level, promote regional forecasting process and provide a scientific basis for accurate forecasting and prevention and control of *C. suppressalis*.

3.3 Strengthening regional comprehensive prevention and control, and taking various technical measures

3.3.1 Cleaning stubble and tillage, pouring water to kill larvae, and reducing the base number of *C. suppressalis* population. It is recommended to implement low stubble harvesting, reduce rice pile height as much as possible during late rice harvesting, carry out rice pile smashing, reduce the amount of wintering insects; according to the monitoring situation of regional *C. suppressalis*, implement tillage and put the residual stubble and straws into soil for winter idle paddy field and manure field, pour water to submerge for 7 – 10 d, so as to kill wintering generation larvae and reduce the base number of *C. suppressalis* population.

3.3.2 Planting *Vetiveria zizanioides* (L.) Nash to attract *C. suppressalis* to reduce the amount of eggs in the field. It is recommended to plant *V. zizanioides* (L.) Nash along two sides of tillage roads of the paddy field to attract *C. suppressalis*, the spacing should be 3 – 5 m, to trap the *C. suppressalis* and reduce the amount of eggs in rice.

3.3.3 Setting traps in a large area to attract and kill adult *C. suppressalis* in the whole process. From the wintering generation adult *C. suppressalis* emerging stage, it is recommended to use *C. suppressalis* sex attractant to trap and kill adult male *C. suppressalis*; use the sex attractant in a large area, set 15 set attractants for one hectare of paddy field, and adopt the same method for non-paddy field; the setting height of sex attractant should be 50 – 80 cm above the ground, and adopt long-term attractant chips with effect longer than two months, and promptly replace the attractant chips.

3.3.4 Properly adjusting the prevention and control strategies, and using pesticides in a scientific and precise manner. It is recommended to take prevention and control measures in accordance with the different base number of *C. suppressalis* population in different regions. For example, for double harvest rice in single harvest and double harvest mixed planting regions with large base

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"dream" will focus on feasibility of the project, put the needs of college students at the first place, and concern change of talent market in a new way. The training process of college students is created that meets not only enterprises' needs but also standpoint of cultivating creativity of college students, which could truly provide service for undergraduates filling "double creation" project.

References

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number of C. suppressalis population, it is necessary to take strict control of C. suppressalis, attach great importance to the prevention and control of fourth generation of C. suppressalis; for single harvest rice in single harvest and double harvest mixed planting regions with large base number of C. suppressalis population, it is necessary to focus on the prevention and control of two key points of front and tail peaks of the second generation of C. suppressalis, to reduce the base number of the third generation of C. suppressalis. Finally, it is recommended to select the appropriate pesticide, strictly control the pesticide application volume and times, and strengthen the rotation of pesticides, to slow down the drug resistance of C. suppressalis.

References

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