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Research Article

Reproductive Rate of Rice Brown Planthopper Population of Super Rice Yongyou 6

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Abstract: In order to improve the cost-effective control of occurrence and damage of rice brown planthopper, Study of super indica japonica hybrid rice Yongyou 6 of brown planthopper population reproduction rate density effect. The reproductive rate and variation dynamics of rice brown planthopper in super rice was also investigated and analyzed. Field test results showed that the population amount of rice brown planthopper in super rice during tillering stage and booting stage gradually increased with the increasing amount of released pest and its growth amount gradually increased with the advancement of growth stage. However, as the density reached a certain limit during gain filling stage (>250 head/cluster), the population amount during maturity stage showed decline trend with the increasing density.

Keywords: Reproductive rate, rice brown planthopper, super indica and japonica hybrid rice, variation dynamic, Yongyou 6

INTRODUCTION

Brown planthopper (Nilapavata lugens (Stal)) is migratory pest with high virulence in high yield cultivation of super rice. In the 21st century, due to the changes of cultivation system with single cropping of rice as the major, the area of super rice is gradually expanded year by year. Tall plant, much earlier sowing period and elongated growth period, as well as obvious earlier immigration period, obvious increase immigration peak and significantly elongated major period of Brown Planthopper (BPH) make the disaster frequency of the pest in super rice significantly increase and rice brown planthopper has become the major obstacle for the current ultra-high yield cultivation of super rice (Chen, 2007; Li *et al*., 2007). Because rice brown planthopper is a migratory pest, the following problems are inevitably existed: the factors affected population dynamics are complex, field experiment is difficult to control, the investigation work is large and the study cycle is long. Few study on brown planthopper population reproduction rate and dynamic changes of Super hybrid rice Yongyou 6 different growth period. Therefore, to establish and improve monitoring and early warning system of rice brown planthopper and to improve the sustained control ability of the pest to achieve cost-effective ecological control of occurrence and damage of rice brown planthopper in super rice, the author carried out study on reproductive rate of rice brown planthopper population in super rice Yongyou 6 and its change dynamics and the results were shown as follows.

MATERIALS AND METHODS

Chemicals Test site was selected in Jianchuan Village of Shaojiadu in Linhai City, Zhejiang Province. The test field was a winter fallow field and the soil in the field was loam with moderate fertility and convenient irrigation and drainage.

The variety used in the test was super indica and japonica hybrid rice Yongyou 6 which was one of the major cultivars in local place. The rice was cultivated in the way of single cropping of rice.

Tested varieties Yongyou 6 was shown on June 8, 2011, which was immediately covered with 28 mesh gauze cage after sowing and the gauze cage could be temporarily moved as the seedlings needed to be transplanted on July 1. 54 plots were set in the field, each plot was planted with 5 lines and each line contained 5 clusters (totally 25 clusters). Plant density was 140000 clusters/hm^2. All the plots were immediately covered with the same number of gauze cages (length 1.3 m, width 1.3 m, height 2.0 m) after

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transplanting until the harvest. All the other field managements were the same as the conventional cultivation fields. Only the diseases in the field were prevented and the pests were not controlled.

Fertilizer application condition was as follows: a total of 375 kg/hm^2 urea (50% of basal fertilizer, 35% of first top dressing, 15% of panicle fertilizer) was applied. In addition, basal fertilizer was added with 300 kg/hm^2 superphosphate, the first top dressing and panicle fertilizer were added with 150 and 37.5 kg/hm^2 potassium chloride, respectively.

The tillering stage during July 30-31 was the peak period of low instar nymph of five-third rice brown planthopper. Six treatments including release of 2-3 instars nymph of rice brown planthopper according to 1, 2, 3, 4 and 5 head/cluster, as well as without release of the pest were set in the test. Each treatment contained three repeats with a total of 18 plots. The pest amounts were recorded at booting stage (August 26), grain filling stage (September 22) and milking stage (October 22), respectively. The population reproduction and change dynamics of rice brown planthopper in super rice during tillering stage were analyzed.

The booting stage during August 26-28 was the peak period of low instar nymph of six-fourth rice brown planthopper. Six treatments including release of 2-3 instars nymph of rice brown planthopper according to 2, 4, 6, 8 and 10 head/cluster, as well as without release of the pest were set in the test. Each treatment contained three repeats with a total of 18 plots. The pest amounts were recorded at grain filling stage (September 22) and milking stage (October 22), respectively. The population reproduction and change dynamics of rice brown planthopper in super rice during tillering stage were analyzed.

The grain filling stage during September 22-24 was the peak period of low instar nymph of seven-fifth rice brown planthopper. Six treatments including release of 2-3 instars nymph of rice brown planthopper according to 30, 40, 50, 60 and 70 head/cluster, as well as without release of the pest were set in the test. Each treatment contained three repeats with a total of 18 plots. The pest amounts were recorded at milking stage (October 22). The population reproduction and change dynamics of rice brown planthopper in super rice during tillering stage were analyzed.

RESULTS AND DISCUSSION

Relationship between release amount of rice brown planthopper during tillering stage and its reproduction dynamics analysis.1, 2, 3, 4 and 5 heads of 2-3 instars nymph of rice brown planthopper were released in each cluster of super rice during tillering stage, the population reproduction and the change dynamics in various treatments were shown in Table 1. As shown in Table 1, rice brown planthopper population in super rice had high reproductive capacity and the growth rate of its population was basically consistent. The population growth rate of the pest from tillering stage to booting stage increased for 4.90, 4.95, 5.23, 4.58 and 4.34 times, respectively with an average of 4.80 times. The population growth rate from tillering stage to gain filling stage increased for 256.4, 208.3, 184.3, 140.3 and 120.0 times respectively with an average of 181.9 times and the population growth rate from booting stage to gain filling stage increased for 52.3, 84.2, 105.7, 122.7 and 138.2 times respectively with an average of 100.6 times. However, the population growth and differentiation of rice brown planthopper from tillering stage to milking stage was more obvious, the growth rate of various treatments from tillering stage to milking stage had large difference, which increased for 1222.0, 577.8, 355.6, 241.7 and 190.0 times, respectively with an average of 517.5 times; the population growth rate from tillering stage to booting stage increased for 249.4, 116.7, 67.9, 52.8 and 43.8 times, respectively with an average of 106.1 times and the population growth rate from booting stage to milking stage increased for 4.77, 2.77, 1.93, 1.72 and 1.58 times, respectively with an average of 2.56 times. Thus, the development of rice brown planthopper population in super rice showed the characteristics of fast in the middle and slow in two ends. This was because that the reproduction rate of rice brown planthopper had close relationship with its food and microclimate in field. With the fluctuation of field plant nutrition and microclimate, the growth rate of population showed growth and decline curve, forming the characteristics of high virulence and high reproduction.

After statistical analysis, the amount of rice brown planthopper population during booting stage showed significantly positive correlation with the basal amount of population during tillering stage and the correlation model was $Y = 4.2X + 1.5$ ($n = 5$, $r = 0.9893$). The amount of rice brown planthopper population during gain filling stage also showed significantly positive correlation with the basal amount of population during booting stage and the correlation model was $Y = 20.4846X + 188.59$ ($n = 5$, $r = 0.9707$). However, the amount of rice brown planthopper population during milking stage showed significantly negative correlation with the basal amount of high density population during gain filling stage and the correlation model was $Y = -0.7779X + 1443.63$ ($n = 5$, $r = -0.9351$). This indicated that as the rice brown planthopper population during gain filling stage reached a certain limit with the increasing density (>250 head/cluster), its population amount showed decline trend with the increasing density. This was due to the integrated effect of food condition and field microclimate.

Relationship between release amount of rice brown planthopper during booting stage and its reproduction dynamics analysis.2, 4, 6, 8 and 10 heads of 2-3 instars nymph of rice brown planthopper were released in each cluster of super rice during tillering stage, the population reproduction and the change dynamics in various treatments were shown in Table 2. As shown in Table 2, the population growth rate of rice brown planthopper from booting stage to gain filling stage

Table 1: Population reproduction and quantity dynamics of rice brown planthopper after release of different amount of the pest in super rice during tillering stage

No. of treatment	Release amount of pest during tillering stage //head/cluster	Pest amount during booting stage//head/ cluster	Reproductive rate from tillering stage to booting stage//times	Pest amount during gain filling stage//head/cluster	Reproductive rate from tillering stage to gain filling stage//times
1	1	4.9	4.90	256.4	256.4
2	2	9.9	4.95	416.6	208.3
3	3	15.7	5.23	553.0	184.3
4	4	18.3	4.58	561.3	140.3
5	5	21.7	4.34	599.8	120.0
Average	3.0	14.1	4.80	477.4	181.9

No. of treatment	Reproductive rate from booting stage to gain filling stage//times	Pest amount during milking stage//head/ cluster	Reproductive rate from tillering stage to milking stage//times	Reproductive rate from booting stage to milking stage//times	Reproductive rate from gain filling stage to milking stage//times
1	52.3	1222.2	1222.0	249.4	4.77
2	42.1	1155.6	577.8	116.7	2.77
3	35.2	1066.7	355.6	67.9	1.93
4	30.7	966.7	241.7	52.8	1.72
5	27.6	950.0	190.0	43.8	1.58
Average	37.6	1072.2	517.5	106.1	2.56

Pest release and investigation period: Release date at tillering stage was 7/30-31; Investigation dates during booting: Filling and milking stage were 8/26, 9/22 and 10/22, respectively; The unit of pest amount was head/cluster; Reproductive rate: Reproduction amount of pest/release amount of pest

Table 2: Population reproduction and quantity dynamics of rice brown planthopper after release of different amount of the pest in super rice during booting stage

No. of treatment	Release amount of pest during booting stage//head/cluster	Pest amount during gain filling stage //head/cluster	Reproductive rate from booting stage to gain filling stage//times	Pest amount during milking stage //head/cluster	Reproductive rate from booting stage to milking stage//times	Reproductive rate from gain filling stage to milking stage//times
1	2	12.0	6.00	466.7	233.35	38.89
2	4	25.4	6.35	950.0	237.50	37.40
3	6	38.8	6.47	1150.1	191.68	29.64
4	8	52.7	6.59	1200.4	150.05	22.78
5	10	64.3	6.43	917.0	91.70	14.26
Average	6.00	38.64	6.37	936.84	180.86	28.59

Table 3: Population reproduction and quantity dynamics of rice brown planthopper after release of different amount of the pest in super rice during gain filling stage

No. of treatment	Release amount of pest during gain filling stage//head/cluster	Pest amount from gain filling stage to milking stage//head/cluster	Pest amount during milking stage//head/cluster	Reproductive rate from gain filling stage to milking stage//times
1	30	76	92.0	3.07
2	40	90	133.1	3.33
3	50	102	173.3	3.47
4	60	118	233.0	3.88
5	70	133	293.2	4.19
Average	50.00	103.80	184.92	3.59

(about 25 d) increased for 6.0, 6.35, 6.47, 6.59 and 6.43 times, respectively with an average of 6.37 times. The population growth rate from booting stage to milking stage (about 55 d) was the largest, which increased for 233.35, 237.50, 191.68, 150.05 and 91.70 times, respectively with an average of 180.86 times. The population growth rate from gain filling stage to milking stage (about 30 d) increased for 38.89, 37.40, 29.64, 22.78 and 14.26 times, respectively with an average of 28.59 times. Thus, rice brown planthopper population in super rice during middle and late stage still had high reproductive capacity, which had great threat to yield.

After statistical analysis, the amount of rice brown planthopper population during gain filling stage showed significantly positive correlation with the basal amount of population during booting stage and the correlation model was $Y = 6.595X - 0.93$ ($n = 5$, $r = 0.9996$). However, the amount of rice brown planthopper population during milking stage had no significant correlation with the basal amount of population during tillering stage ($n = 5$, $r = -0.6437$). This indicated that the development of B rice brown planthopper population from booting stage to gain filling stage increased with the increasing basal density and the correlation was not significant till the milking stage. This was due to the integrated effect of food condition and field microclimate during late stage of super rice.

Relationship between release amount of rice brown planthopper during gain filling stage and its reproduction dynamics analysis. (30, 40, 50, 60 and 70 heads) of 2-3 instars nymph of rice brown planthopper were released in each cluster of super rice during tillering stage, the population reproduction and the change dynamics in various treatments were shown in Table 3. As shown in Table 3, the population growth rate of rice brown planthopper from gain filling stage to milking stage (about 30 d) increased for 3.07, 3.33, 3.47, 3.88 and 4.19 times, respectively with an average of 3.59 times. The growth rates of various treatments were basically consistent.

After statistical analysis, the amount of rice brown planthopper population during milking stage showed significantly positive correlation with the basal amount of population during gain filling stage and the correlation model was $Y = 5.023X - 66.23$ ($n = 5$, $r = 0.9949$). This indicated that as the population density of rice brown planthopper during gain filling stage was less than 70 head/cluster, the population development of rice brown planthopper increased with its increasing basal density. So rice brown planthopper still had great threat to yield.

CONCLUSION

Field test results showed that the population amount of rice brown planthopper in super rice during tillering stage and booting stage gradually increased with the increasing amount of released pest and its growth amount gradually increased with the advancement of growth stage. However, as the density reached a certain limit during gain filling stage (>250 head/cluster), the population amount during maturity stage showed decline trend with the increasing density. This is because that population development is affected by the combined effect of internal density constraints and external environment. The population of rice brown planthopper during gain filling stage had gentle development with the increasing amount of released pest. This is because the population development is affected by the food condition and field microclimate.

Overall, rice brown planthopper population in super rice has high reproductive capacity and its population growth rate during various growth stage of super rice is basically consistent. The development of rice brown planthopper population shows the characteristics of fast in the middle and slows in two ends. This is because that the reproduction rate of rice brown planthopper has close relationship with its food and microclimate in field. With the fluctuation of field plant nutrition and microclimate, the growth rate of population shows growth and decline curve, forming the characteristics of high virulence and high reproduction. The result has important significance for establishment and improvement of monitoring early warning system, cost-effective control of occurrence and damage of rice brown planthopper and improvement of the sustained control ability against B rice brown planthopper (Zang and Hao, 1997).

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