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POPULATION INTENSITY OF PANICLE RICE MITE *STENEOTARSONEMUS SPINKI* SMILEY (ACARI:TARSONEMIDAE) INFLUENCING RICE YIELD IN VIETNAM

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ABSTRACT

A study was conducted to evaluate the effect of panicle rice mite (PRM) population on the agronomic characters of dominant rice cultivar IR 50404 by artificial inoculation of 1, 2, 4, 8, 16 and 32 adult female mites per panicle at 30 and 45 days after sowing, respectively in Chau Thanh, An Giang,Vietnam for the second crop season (summer-autumn), 2010. Subsequently, the mite population was assessed at 13 and 28 days after introduction where the highest number, 527 mites per tiller and 835 mites per tiller were recorded, respectively from the 32 adult female mites per panicle treatment. In all the treatments, PRM significantly reduced the height of the plant, panicle weight and the curvature of the panicle, and increased the percentage of sterile inflorescences. The highest yield loss was 89.3% when 32 mites per tiller were introduced at 30 days after sowing. The periods of PRM introduction affected the yield loss but these effects were only significantly smaller when the initial number of mites released was small (1-2 mites per tiller). However these were nearly similar at higher numbers of mites released (4-32 mites per tiller).

Key words: Density-yield relationships, Tarsonoemid mite, rice pests

INTRODUCTION

Steneotarsonemus spinki Smiley (panicle rice mite) is one of key rice pests throughout the world (Tseng, 1984). It has been reported that this mite caused 30 to 90% yield loss in rice in the Caribbean (Almaguel et al., 2000). The occurrence of the panicle rice mite in Vietnam had been recorded in Thua Thien Hue, causing damage to 40 has of rice fields and resulting in 15% empty grains (Ngo Dinh Hoa, 1992). In the last five years, the rice panicle mite has become a major pest in the rice producing areas of Vietnam. Do Thi Dao *et al*. (2008) reported 59.9% more yield in the acaricide treated rice field in comparison with untreated control field. A survey in 7 agro-ecological regions of Vietnam in two years, 2010-2011, showed that rice panicle mite was a dominant rice pest in three major rice-growing areas of Vietnam. The damage was heavier in the second crop season of the years (Duong Tien Vien *et al.*, 2012). After rice harvest, the stubble ratoon crop was the main habitat of RPM and from these habitats the RPM spread throughout the field in the next season (Nguyen Thi Nham *et al.* 2010). However, studies have not been conducted on the effects of crop damage on rice yield in Vietnam. This study aimed to determine the influence of different panicle rice mite densities on the yield of rice variety IR 50404, a dominant rice variety which was cultivated in the summer season (April - August 2010) in the Chau Thanh district, An Giang province, in the Mekong river delta.

MATERIALS AND METHODS

Stock Cultures of *S. spinki*

Panicle rice mites (PRMs) were collected from a rice field at Chau Thanh, An Giang (100 -110 ºN and 104.70 – 105.50 ºW). The PRMs were transferred gently to 5 cm. long segments of rice stem (each containing 1 node at the base of the segment and 1 inter-node) using the tip of a needle. These stem segments were then placed on spongy pads which were watered daily. After 2 weeks when the population of PRMs inside the stem sheath was high, the stem segments containing PRMs were cut into 1cm-segments and then transferred onto new 5cm-stem segments to increase the numbers of available PRMs for artificial infestation in the field.

Influence of PRM Densities on Yield

The experiment was conducted at Chau Thanh, An Giang, Vietnam on a dominant rice cultivar IR 50404. Plots were laid out in a completely randomized design with three replicates. Each plot, 0.5 m x 0.5 m in size, was surrounded with 1.2 m high plastic sheet on its perimeter. Plots were spaced 1 m apart to minimize interference between plots and the adjacent field. The rice was sown with 15 tillers per plot, which was the same density at which the farmer had sown the rest of the field (12 kg seed per 1000 m^2). The treatments included introduction of 1, 2, 4, 8, 16 and 32 female PRM per tiller, respectively. In a previous research, we found that the PRM only appeared in the rice fields from 25-50 days after sowing, so the introduction times in this experiment, were 30 and 45 days after sowing (DAS). At these times, the exact numbers of female PRM required for each treatment were transferred from the culture colonies into the leaf sheath of each rice tiller in the experimental plots.

The densities of PRM were monitored twice, at the booting stage (58 days after sowing) and at maturity (88 days after sowing). For the first assessment, 5 tillers were cut randomly in each plot, the PRM in each leaf blade and leaf sheath of each tiller were counted, the length of the lesions was measured and the colour of the largest lesion inside each rice sheath was recorded. For the second assessment, 30 tillers per plot were randomly selected, cut and recorded these parameters: the height of each tiller (from the foot to the tip of the panicle), the total numbers of grains per panicle, the numbers of filled grains, the number of grains damaged by PRM per panicle, panicle weight and panicle curvature (the angle between the vertical axis (stem) and the tip of the panicle). The number of predatory mites was also recorded. However, the density was quite low and there was no significant difference among the treatments. So this was not mentioned in this paper.

Data analysis

One-way analysis of variance (ANOVA) was used to compare the influence of the number of PRM introductions on plant height, panicle weight, the percentage of sterile inflorescences and the curvature of the panicle. Mean values were compared among factors using the LSD test in CropStat Ver. 7.2 (International Rice Research Institute). Linear regression was used to determine the relationship between the number of PRM introductions and the densities of mites per tiller at 13 days and 28 days after introduction, the weight of filled grains/panicle and percentage of empty grains per panicle.

RESULTS

Population Development

At the booting stage, 13 days and 28 days after PRM introduction, the densities of PRM were clearly higher than the control in all the treatments and the numbers of PRM increased as the number of PRM introductions increased at both intervals after introduction (Table 1).

Table 1. Densities of panicle rice mite (± SE) at 13 and 28 days after introduction.

Number of PRM introduced per tiller	Density of PRM (mites per tiller)*	
	28 DAI**	**13 DAI**
0	0 ± 0 a	0 ± 0 a
1	57.33 ± 3.02 a	48.13 ± 5.13 ab
2	110.07 ± 43.25 ab	143.47 ± 26.94 bc
4	214.53 ± 15.11 bc	185.67 ± 27.24 cd
8	341.67 ± 40.54 c	255.60 ± 23.71 d
16	551.20 ± 47.09 d	282.20 ± 46.46 d
32	834.67 ± 103.10 e	526.60 ± 56.50 e

*Means within a column followed by the same letter are not significantly different at 0.05 level in an LSD test; **DAI: Days After Introduction of PRM

The highest numbers of PRM (526.6 mites per tiller after 13 days, 834.7 mites per tiller after 28 days) were observed when 32 PRM had been introduced per tiller, i.e. 16.5 and 26.1 times higher than the initial numbers introduced, respectively. The common slopes estimate for both 13 and 28 days after introduction were positive and significantly different from zero, showing an increase in numbers of PRM as the numbers of PRM introduced increased (Fig. 1).

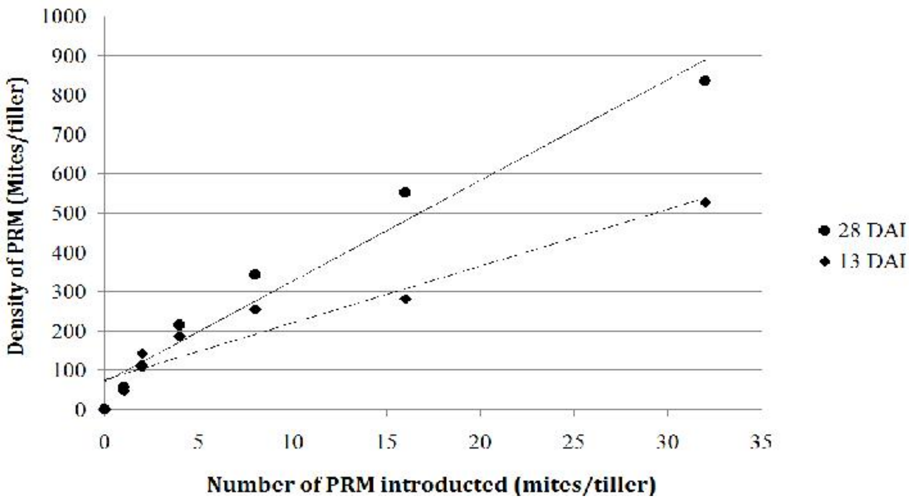


Fig. 1. The relationship between the numbers of mites introduced and the densities of mites per tiller at 13 days and 28 days after introduction. 28DAI: y = 25.58x + 71.14, R= 0.981 (F=125.34, P <0.001, df=6); 13DAI: y = 14.43x + 76.10, R=0.953 (F= 50.024, P = 0.001, df=6); DAI: days after introduction of PRM

Impact on yield

For determining the effect of the different PRM mite densities on the agronomic characters of the rice plant, at maturity (88 days after sowing) 30 random tillers were checked. The results indicated that all rates of PRM introduction significantly affected plant height, panicle weight, sterility percentage and panicle curvature in comparison with the control treatment. The degree of dwarfing of the rice plants was roughly proportional to the numbers of PRM released per tiller. The plants were smallest with the 16 and 32 mites per tiller introduction rates at both introduction times (30 and 45 days after sowing), the plant height being reduced by 14.2 – 17.2 cm compared with the control (Table 2 and 3). In addition, other symptoms observed in infected plants were black lesions in the leaf sheath, off-colour plants, blackened rice husks and deformed grains.

Table 2. Influence of the density of PRM introduced 30 days after sowing on different agronomic characters of rice

Number of mites introduced per tiller	Plant height (cm)* Mean ± SE	Filled grain weight (g per panicle)* Mean ± SE	Reduction in weight (%)	Percent empty grains per panicle (%)* Mean ± SE	Increase in percent empty grain (%)	Panicle angle (^{o})* Mean ± SE
0**	85.41 ± 0.32c	2.25 ± 0.01 f	0	21.48 ± 3.12 a	0	93.72 ± 2.94 e
1	77.00 ± 1.68ab	1.55 ± 0.12 e	31.11	37.66 ± 2.39 b	42.96	72.04 ± 8.11 de
2	77.68 ± 1.74b	1.39±0.04 de	38.22	40.50 ± 1.22 bc	46.96	67.62 ± 4.95 cd
4	74.65 ± 2.90ab	1.07±0.16 cd	52.44	52.53 ± 4.98 c	59.11	52.53 ± 6.42 bcd
8	75.46 ± 1.23ab	0.74±0.22 bc	67.11	68.18 ± 8.77 d	68.50	46.53 ± 11.66 bc
16	71.24 ± 2.85a	0.41±0.13 ab	81.78	72.77 ± 4.49 de	73.47	39.66 ± 9.65 ab
32	71.38 ± 1.31a	0.23 ± 0.04 a	89.33	87.88 ±1.54 e	75.56	22.49 ± 1.94 a

*Means within a column followed by the same letter are not significantly different at 0.05 the level in an LSD test; ** Control

Table 3. Influence of the density of PRM introduced 45 days after sowing on different agronomic characters of rice

Number of mites intro-duced per tiller	Plant height (cm)* Mean ± SE	Filled grains weight (g per panicle)* Mean ± SE	Reduction in weight (%)	Percent empty grains per panicle (%)* Mean ± SE	Increase in percent empty grain (%)	Panicle angle (^{o})* Mean ± SE
0**	89.88 ± 0.82 c	2.51 ± 0.09 d	0.00	15.57 ± 4.73 a	0.00	93.61 ± 3.06 c
1	83.53 ±1.40 b	1.93 ± 0.02 c	23.11	28.06 ± 0.41 b	44.51	85.11 ± 1.50 bc
2	81.44 ±0.43 b	1.80 ± 0.08 c	28.29	31.30±1.40 bc	50.24	80.11 ± 1.50 bc
4	82.57 ±0.71 b	1.47 ± 0.06 b	41.43	38.67±2.06 cd	59.74	76.39 ± 1.51 b
8	80.94 ±0.52 b	1.26 ± 0.04 b	49.80	45.68 ± 2.18 d	65.15	72.89 ± 2.35 b
16	72.44 ± 2.42 a	0.46 ± 0.12 a	81.67	79.02 ± 6.12 e	80.45	45.81 ± 11.14 a
32	72.58 ± 0.83 a	0.35 ± 0.02 a	86.06	83.17 ± 0.48 e	81.28	41.33 ± 1.83 a

*Means within a column followed by the same letter are not significantly different at 0.05 the level in an LSD test; ** Control

The panicle curvature of rice plants infected with PRM was easy to observe in the field in comparison with uninfected ones; therefore this symptom was used as one of the criteria to determine the effect of the PRM on the rice plant. The angle between the stem and the tip of the panicle was measured to determine the panicle curvature. Panicles damaged by PRM will be lighter in weight, so the angle will be smaller than the angle of normal plants. The data from Tables 2 and 3 demonstrated that when the densities of PRM increased, the angle of the panicle was reduced. The smallest panicle angle was observed in the 32 mites per tiller treatment with angles of 22.5^o and 41.3^o at 30 DAS and 45 DAS, respectively.

The effect of PRM introduction density on yield loss was also apparent. Both PRM introduction times (30 DAS and 45 DAS), the mean weight of filled grains per panicle decreased from 2.25 and 2.51 g (control) to 0.23 and 0.35 g (32 mites per tiller treatment), respectively while the percentage of the empty grains increased as the densities of PRM increased. In the 32 mites per tiller treatment, almost all of the grains in the panicle were empty with an average percentage of empty grains of 87.9% and 83.2% for the two introduction times, respectively.

The slopes relating the densities of PRM introduced to the weight of filled grains per panicle and percentage of empty grains per panicle were significantly different from zero. However, the relationship between the number of PRM introduced and the weight of filled grains per panicle was negative, with R values of -0.828 and -0.885 at 30 DAS and 45 DAS, respectively, while the relationships of PRM introduction density with percentage of empty grains were positive with R values of 0.888 and 0.921 at 30 DAS and 45 DAS, respectively (Fig. 2).

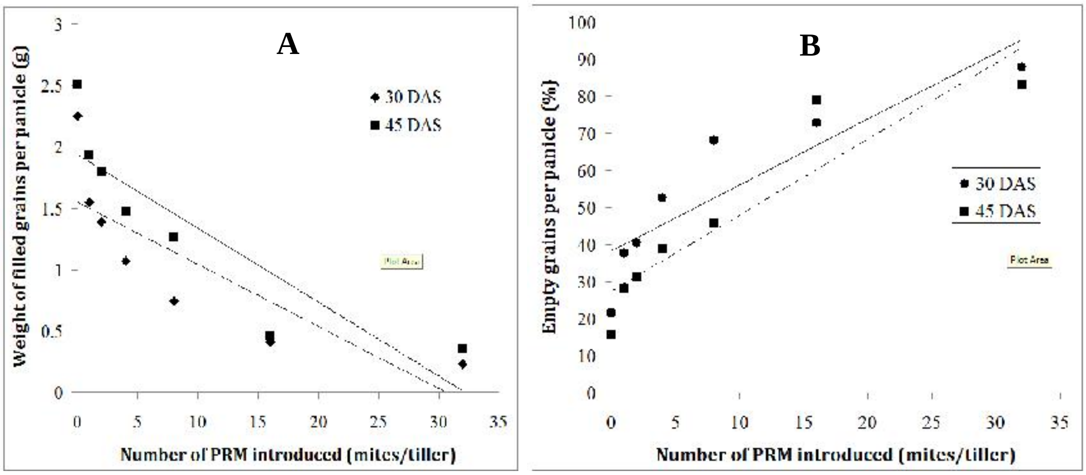
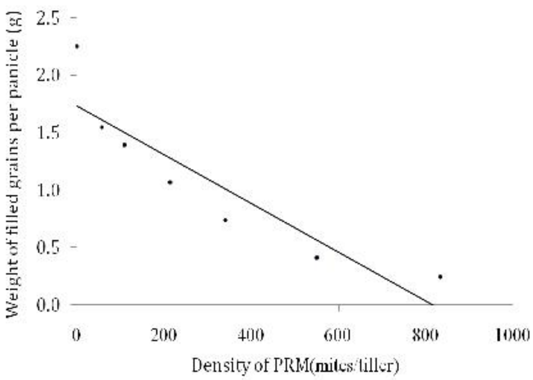


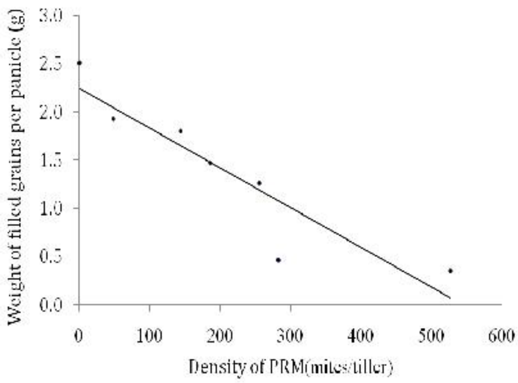
Fig. 2. The relationship between the numbers of mites introduced (mites per tiller) and the weight of filled grains/panicle and percentage of empty grains per panicle at the two introduction times A: 30 DAS y = -0.051x + 1.546, R = - 0.828 (F = 10.879, P = 0.022, df = 6); 45 DAS y = -0.060x + 1.938, R = 0.885 (F = 18.024, P = 0.008, df = 6); B: 30 DAS y = 1.782x + 38.39, R= 0.888 (F = 18.733, P = 0.008, df = 6); 45 DAS y = 2.059x + 27.391, R = 0.921 (F = 27.940, P = 0.003, df = 6)

Similarly, at the booting stage (58 DAS), the slopes relating the numbers of mites per tiller to full grain weight per panicle were negative and significantly different from zero (Fig. 3).

The PRM introduction times also influenced on the weight of filled grains. PRM released at the low densities of 1 and 2 mites per tiller at 30 DAS significantly reduced the weight of filled grains more than the same numbers of mites released at 45 DAS. However the higher density treatments (4, 8, 16, and 32 mites per tiller) did not result in differences in the weight of the filled grains between the two introduction times (Fig. 4).



30 DAS



45 DAS

Fig. 3. The relationship between numbers of mites at the booting stage and the weight of filled grains per panicle. 30DAS: y = -0.002x + 1.735, R = -0.913 (F = 25.125, P = 0.004, df = 6); 45DAS: y = - 0.004x + 2.247, R = -0.919 (F = 27.164, P = 0.003, df = 6)

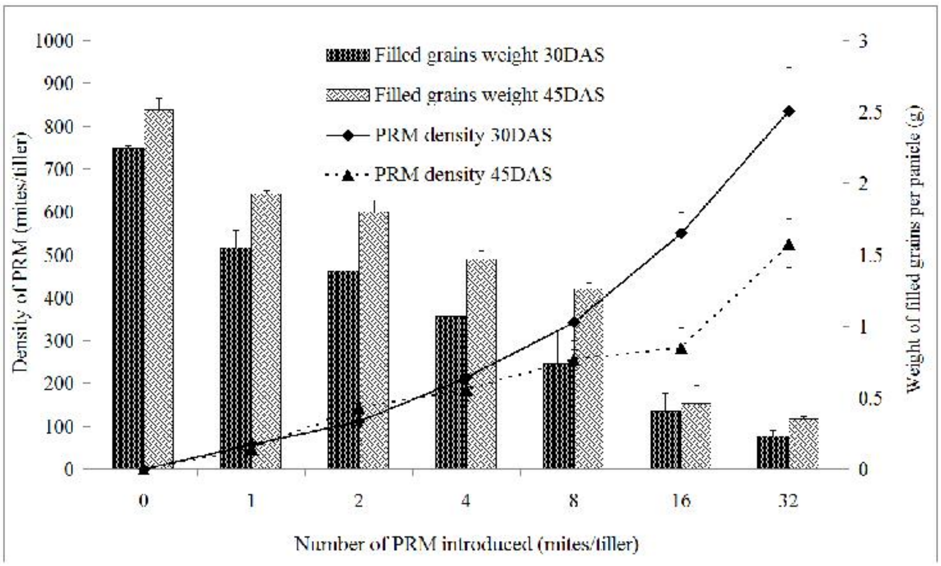


Fig. 4. Influence of two PRM introduction times at 30 and 45 DAS on weight of filled grains per panicle (g)

DISCUSSION

Panicle rice mite is able to create a population boom in a short time (Tseng, 1984) as the results of this experiment again demonstrate. The numbers of PRM in the 32 mites/tiller treatment increased 16.5 and 26.1 fold after 13 and 28 days, respectively, from the initial number introduced. This result was similar to that reported by Ramos and Rodríguez (2001) where the population of PRM multiplied by 24 times at the green ring stage. The ability of the PRM population to increase rapidly may be related to the high temperature and high humidity in An Giang, averaging 28.3^{o}C and 81.4%, respectively, between April and August over the period of 2001 – 2010 (data from website of Vietnam

Institute of Meteorology Hydrology and Environment, 2010). When compared the population growth of different treatments we found that the population growth was fastest in low initial numbers of PRM introduced (1 mite per tiller was 57.33 times at 28 DAI and 71.74 times in 2 mites per tiller treatment at 13 DAI). The population growth decreased as the numbers of PRM introduced per tiller were increased. When the number of PRM in a population was too high, there would be space and food shortage causing the population to grow slowly.

Panicle rice mite caused significant yield loss at all introduction rates. The yield loss increased as the number of PRM introduced increased. When only one mite per tiller was released, the weight of filled grains per panicle was reduced by 31.1% and 23.1% in comparison with the control at 30 DAS and 45 DAS, respectively (Table 2 and 3). The yield loss reached a maximum of 89.3% with 87.9% sterility for the 32 mites per tiller treatment at 30 DAS. These finding were similar to those reported by Rao and Prakash (2003) in Orissa, India, where densities of 7 – 600 mites per tiller caused 4 - 90% sterility.

The time of PRM introduction affected the severity of yield loss. However, this effect was only significant when the initial numbers of mites released was low (1-2 mites per tiller) and nearly similar when the numbers of mites released were higher (4-32 mites per tiller). This may be attributed to a low initial number of PRM at the low introduction rates, the 15 days difference in time between the 30 and 45DAS introductions being too short for the PRM to make a difference in density of PRM on the maturity stage, while with the higher initial numbers of PRM, the main factor which affected the increase in the population was not the time, but the limited food source.

CONCLUSIONS

At the booting stage, an increase in numbers of PRM as the numbers of PRM introduced increased, the highest numbers of PRM were observed when 32 PRM had been introduced per tiller. All rates of PRM introduction significantly affected plant height, panicle weight, sterility percentage and panicle curvature in comparison with the control treatment. The smallest plants were reduced by 14.2 – 17.2 cm with the 16 and 32 mites per tiller introduction rates. For both PRM introduction times (30 DAS and 45 DAS), the mean weight of filled grains per panicle decreased while the percentage of the empty grains increased as the densities of PRM increased. The periods of PRM introduction (30 DAS and 45 DAS) affected the yield loss at low densities.

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