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Timing of Buprofezin Application for Control of the Brown Planthopper, *Nilaparvata lugens* Stål (Homoptera: Delphacidae)

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Field trials were conducted to estimate the optimal application timing of buprofezin, a molt-inhibiting IGR, for the control of the brown planthopper, *Nilaparvata lugens* Stål, over a 3 year period from 1979 to 1981. Buprofezin was applied at various times of nymphal development stages during August and September. The effects of buprofezin to the BPH were assessed by degree of reduction in the posttreatment density of nymphs. The optimal application timing was found to be mid-nymphal stages of 2nd generation, ca. 7-14 days after the peak percentage of young nymphs when the percentage had dropped below 50%. By contrast, applications at the early-nymphal stages were relatively ineffective and caused a considerable posttreatment increase of nymphal density.

INTRODUCTION

The brown planthopper, *Nilaparvata lugens* Stål (BPH), is an economically important rice pest of major concern in the southern half of Japan as in most of the rice producing countries in Asia. Control of the BPH in our country has been achieved exclusively by repeated applications of insecticides.

Organophosphates and carbamates have been used in the control, but gradual increase in the resistance levels to these insecticides was observed in the immigrant BPH (Nagata et al., 1979; Kilin et al., 1981).

Buprofezin (2-*tert*-butylimino-3-isopropyl-5-phenyl 3, 4, 5, 6-tetrahydro-2H-1, 3, 5-thiadiazine-4-one) is a promising chemical developed recently and has been commercialized since 1984 in Japan. Its mode of action is quite different from the conventional insecticides. It is a molt-inhibiting IGR (insect growth regulator) which inhibits chitin synthesis of insects (Uchida et al., 1985). Though buprofezin lacks an immediate insecticidal effect, it offers the advantage of longer residual activity against BPH nymphs than conventional insecticides. In addition, it exhibits low toxicity to fish and low impact on beneficial insects in rice paddy. However, little information is available on the best timing for its application. The author therefore undertook an investigation on the relationship between the application timing and suppression of population growth of the BPH in rice paddies to maximize the control potential of this chemical. The experiments were conducted over a period of 3 years from 1979 to 1981 at Chikugo, Fukuoka Prefecture, Kyushu.

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1979 EXPERIMENT

Materials and methods

The purpose of the experiments in 1979 was to compare the effects of buprofezin with those of conventional insecticides then used against the BPH. Migratory BPH adults invaded the paddy field in late June in 1979 as was usual in this area. A 36 m^2 field plot was planted with the Reiho rice variety, a BPH susceptible variety, on 15 June. In each experiment during the three years, insecticide applications were replicated two times. Counts of the nymphs on 40 hills in each plot were made by the sticky board method described by NAGATA and MASUDA (1978). The basal part of hills were beaten by hand, the nymphs were captured on the board and were then counted in the laboratory classifying the instar. Developmental stages of the nymphs was estimated in an insecticide-free monitoring plot. Thirty hills were sampled with two sticky boards at intervals of 3 to 5 days. The results were expressed as an average percent of young nymphs (PYN), (number of 1st- and 2nd-instar nymphs/total number of nymphs captured). Each generation was clearly separated by PYN as seen in Fig. 1. However, in the calculation of PYN, young nymphs of the white backed planthopper, *Sogatella furcifera*, were included because the two species were not segregated in early nymphal

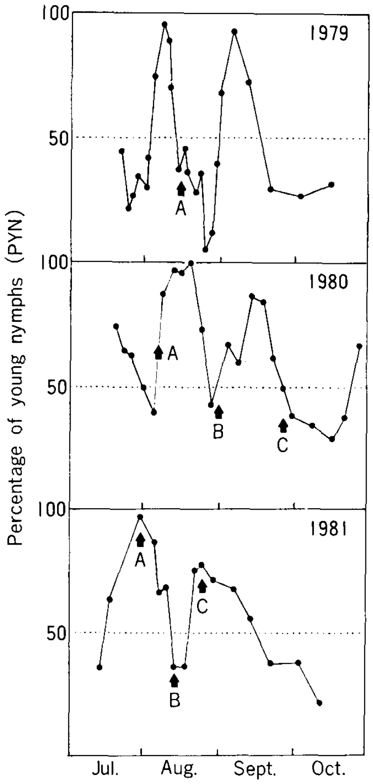

Fig. 1. Percentage of young nymphs (PYN) and application time of buprofezin. Arrows indicate application times.

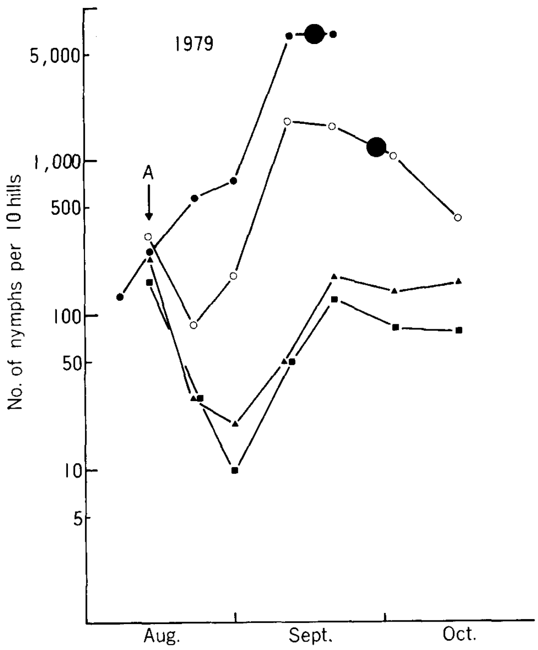

Fig. 2. Effects of buprofezin applied at mid-nymphal stage of 2nd generation, 1979. ●: untreated, ○: MIPC granules, ▲: buprofezin dust (AI. 1.0%), ■: buprofezin dust (AI. 1.5%), ●: onset of hopperburn. Arrow indicates date of application-A.

stage. A small hand duster or hand broadcasting was used for the application of insecticides. These were applied on 13 August at the mid-nymphal stage (when PYN was ca. 40%, ca. 7 days after the PYN peak) of 2nd generation. (Nymphs from the eggs laid by immigrant adults are designated as 1st generation in this paper) (Fig. 1.). Number of hopperburned hills were counted on 17 October to assess the degree of BPH damage.

Results

Nymphal density in the untreated check plot increased successively during August and September and finally attained 7,000 nymphs per 10 hills. Hopperburn was observed in mid September and 95% of the total area in the untreated plot was damaged by mid October (Fig. 2).

MIPC granules (4% AI.) applied at 2.4 kg (AI.)/ha reduced nymphal density considerably. The minimum density was observed 9 days after treatment, when it was almost equal to that of the untreated plot. Fifty-four and one-half percent of the total plot area was damaged by late September. The effect on BPH of 1% or 1.5% dust of buprofezin applied at 4 kg (AI.)/ha and 6 kg (AI.)/ha, respectively was higher than that of MIPC. The minimum density was 10–20 nymphs per 10 hills 17 days after treatment. These values were much lower than those of MIPC treatments. Nymphal density then increased, but the peak of nymphal density of the 3rd generation was suppressed at the level of 100–200 nymphs per 10 hills and no hopperburn was observed.

1980 EXPERIMENT

Materials and methods

Occurrence of the BPH in 1980 was considerably lower than usual years in this area the maximum of the nymph density in the untreated plot in September being lower than 500 nymphs per 10 hills without hopperburn. Adult hoppers migrated in early July and their density in the fields was nearly half of usual years. A 57 m^2 plot was planted with Reiho variety on 19 June. Application of insecticides was conducted at three different times based on PYN (Fig. 1). In 1980, the precipitation in August was 656 mm, although usual average precipitation in this area is 205 mm.

Results

In application-A, buprofezin was applied just prior to the peak of PYN of the 2nd generation and good control was obtained by 18 days after treatment (Fig. 3). But the increase of nymphal density in the subsequent generation was remarkable and in the 3rd generation it reached 100 nymphs per 10 hills. This density level of the nymph was 1/4 of the untreated plot, and almost equal to the posttreatment density of nymphs in the previous year's experiments.

The effect of buprofezin in application-B was lower shortly after application than application-A. But the degree of suppression of the nymphal density was higher than application-A throughout September and October, and also posttreatment increase of the density of the nymph in the 3rd generation was slight. Rapid suppression of the nymphal density was found in application-C without any sign of posttreatment density increase.

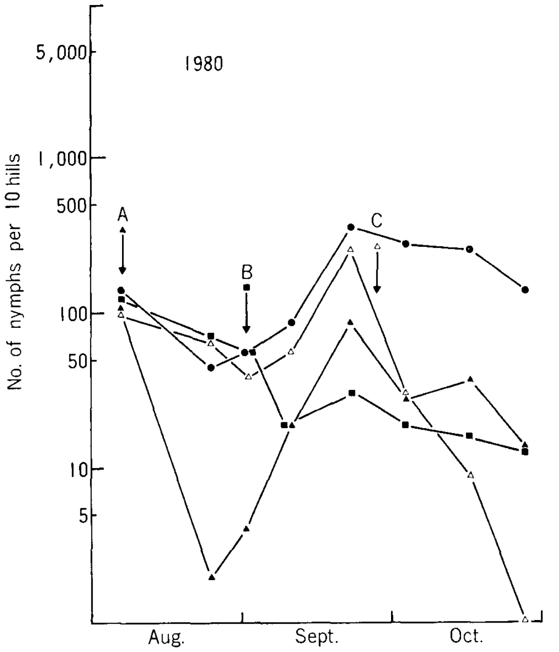

Fig. 3. Effects of buprofezin applied at various times (A, B, C) in 1980. ●: untreated, ▲: application-A (6 Aug.), ■: application-B (1 Sept.), △: application-C (27 Sept.). See Fig. 2 for other symbols.

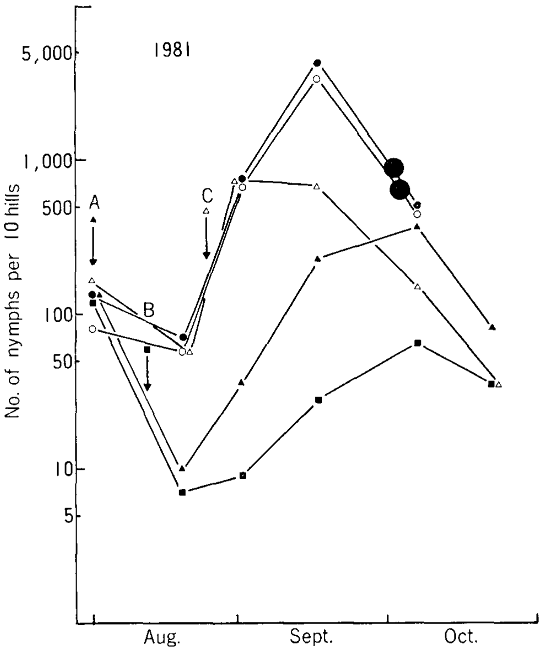

Fig. 4. Effects of buprofezin applied at various times (A, B, C) in 1981. ●: untreated, ○: MTMC dust, ▲: application-A (1 Aug.), ■: application-B (12 Aug.), △: application-C (24 Aug.). See Fig. 2 for other symbols.

1981 EXPERIMENT

Materials and methods

Optimal application timing of buprofezin was determined under heavy BPH infestation conditions. A Major migration of the insect was observed in late June of this year, and occurrence was remarkably greater than in the previous year. A 52 m^2 plot was planted with Reiho variety on 19 June. Buprofezin DL dust (1.5% AI.) was applied three different times at 6 kg (AI.)/ha and MTMC dust (2% AI.) was applied on 1 August at 8 kg (AI.)/ha (Fig. 1.).

Results

Occurrence of the BPH in the untreated plot was about two weeks earlier in 1981 than in 1980. The peak of PYN was observed in early August (Fig. 1), and the peak day of nymph occurrence was 15 September (Fig. 4).

The nymphal density in the untreated plot showed a transitory decline during the later period of nymph occurrence of the 2nd generation, and then increased rapidly again to reach 4,000 nymphs per 10 hills in September, causing hopperburn in 18.5% of the total area of the untreated plot. The peak of nymphal density in the 3rd generation of 1981 was lower than that of 1979. MTMC-dust treatment resulted in quite low suppression of nymphal density. Thirty-seven percent of the total MTMC-treated area was lost by hopperburn, which was greater than the damage in the untreated plot.

In application-A of buprofezin at the peak day of PYN in the 2nd generation, suppression of nymphal density was lower than with MTMC treatment, however, remarkable increase was observed in the 3rd generation and density of the peak day of nymphal occurrence was nearly 400 nymphs per 10 hills. Application-C indicated the slow effect of buprofezin; the nymphal density 8 days after treatment was not reduced at all. The maximum density of the nymph was ca. 700 nymphs per 10 hills. Thus, in both application-A and -C, increase of nymphal density was observed in the 3rd generation; densities reached 400 and 700 nymphs per 10 hills, respectively. Superior control was obtained in application-B, the minimum density of the nymph after treatments was the lowest of these three applications and in the 3rd generation was only 60 nymphs per 10 hills.

DISCUSSION

When the results over the 3-year period were assessed by comparing the population reduction after treatments, good control with high reduction and slight posttreatment increase of nymphal density was obtained in applications made at the mid-nymphal stage of the 2nd generation (1979, application-A, buprofezin 1%; 1979, application-A, buprofezin 1.5%; 1980, application-B; 1981, application-B). In contrast, the effects of application at the peak day of PYN or just prior to that (application-A in 1980, application-A and application-C in 1981) were quite low.

The percentage of cumulative nymphal counts in the treated plot to that in the untreated plot (P) were calculated for each year using the following formula;

$$P=\frac{\sum \text{No. of nymphs in a given treated plot} \times C.F.}{\sum \text{No. of nymphs in untreated plot}} \times 100\ (\%)$$

Where $C.F.$, coefficients for correcting the variation in the initial nymphal densities

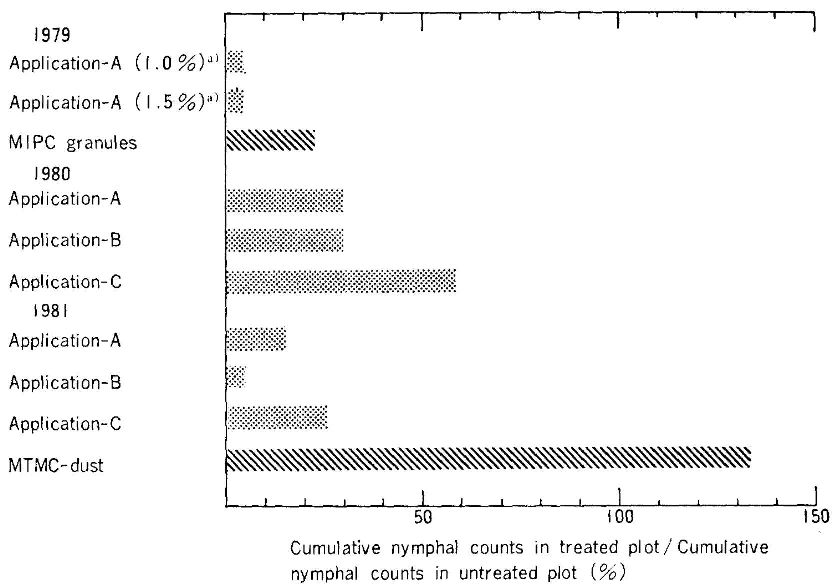

Fig. 5. Effect of buprofezin applied at various times on cumulative nymphal counts.
[a] Concentration of buprofezin in dust (AI.).

among the plots before treatment, are given by the following equation;

$$C.F = \frac{\text{No. of nymphs in untreated plot before treatment}}{\text{No. of nymphs in a given treated plot before treatment}}$$

This assessment also supported that all treatments at mid-nymphal stage in the 2nd generation except application-B in 1980, provided apparently better control with ca. 5% of *P* values, (Fig. 5). It was considered that the results in 1980 were influenced by the unusually heavy rainfall in August as previously mentioned.

When carbamate insecticides were applied at non-optimal timing, effectiveness to the BPH was considerably less than that achieved with the most effective application timing such as the late nymphal stage of the 1st generation, and the period of optimum application timing was very short (NAGATA et al., 1973). In this experiment, however, it appeared that the optimal application period for buprofezin was longer than that for the carbamate insecticides, because control was better with buprofezin even when applied at non-optimal application times.

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