Original Article

Efficacy of Acetamiprid Granule against Cotton Aphid on Cucumber Plants by Various Application Methods

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The various efficacy of acetamiprid granule against the cotton aphid on cucumber plants according to several different applications such as planting hole and soil-surface applications was investigated. In planting hole application, the uncontrolled-release granule showed excellent efficacy when treated at the center of hole dug in soil as well as when treated uniformly in the hole. In case of soil-surface application, the efficacy of the granule exhibited higher activity against the aphid as the distance between the treated point and the foot of the transplanted seedling became shorter within the distance of 5, 10 and 20 cm from the foot of the seedling. The relationship between the efficacy and distance of treated points was the same as in the uncontrolled-release granule. Besides, the influence of the watering volume on the activity was examined. With planting hole application, the activity with lower watering-volume plots was higher than that with higher watering one within the watering volume designed. On the other hand, with soil-surface application the activity against the aphids was inferior to that with planting hole application. Moreover, the effect of watering volume and kind of soil on the activity of the controlled-release granule with planting hole application was examined. It was indicated that a relation between the efficacy and watering volume varied by the kind of soil.

Key words: acetamiprid, granule, planting hole application, soil-surface application, cotton aphid, cucumber plants.

INTRODUCTION

Acetamiprid, (*E*)-*N*¹[(6-chloro-3-piridyl)methyl]-*N*²-cyano-*N*¹-methylacetamidine, is a novel insecticide invented in 1989 by Nippon Soda Co., Ltd. The compound has a broad insecticidal spectrum and is highly effective against insect pests such as Lepidoptera, Hemiptera, Tysanoptera and Coleoptera. Acetamiprid was found to possess an excellent systemic activity against aphids and the diamondback moth.^{1–5)} In the previous reports, acetamiprid 2% granule exhibited practicability against the diamondback moth, *Plutella xylostella* and the green peach aphid, *Myzus persicae*.^{6–8)} The granule was designed to improve efficacy against the diamondback moth, and it was effective also against the green peach aphid on cabbage.⁹⁾ Aphids infest a broad

range of crops and they are serious pests because they have developed resistance to other commercial insecticides. The fact led to the investigation of the efficacy of acetamiprid granule against the cotton aphids on cucumber plants by planting hole and soil-surface applications.

MATERIALS AND METHODS

1. Chemical

The controlled- and uncontrolled-release granules including 1% or 2% acetamiprid were formulated at the Haibara Agricultural Research Laboratory of Nippon Soda Co., Ltd.⁹⁾ The released time of controlled-release granules was 30.7 and 54.7% in 24 and 72 hours after application in water. On the other hand, the released time of uncontrolled-release formulation reached 100% within 3 hours.⁶⁾ Benfuracarb and acephate 5% granules were purchased from commercial source. These formulations were used for the trials.

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Table 1 Physical properties of acetamiprid and standard insecticides.¹⁰⁾

	Acetamiprid	Acephate	Benfuracarb
Solubility in water	4250 mg/l (25°C)	790,000 mg/l (20°C)	8.1 mg/l (20°C)
Partition coefficient (Log P _{ow})	0.8 (25°C)	-0.89	4.3 (20-22°C)
Melting point	98.9 °C	82-89°C	viscous liquid
Vapor pressure	< 1 × 10 ⁻³ mPa (25°C)	0.226 mPa (24°C)	2.66 × 10 ⁻² mPa (20°C)

Fig. 1 Chemical structure of acetamiprid.

2. Insect Pest

The cotton aphid, *Aphis gossypii*, which naturally appeared in the field and the plastic house in the Haibara Agricultural Research Laboratory of Nippon Soda Co., Ltd., was tested. Before and after applying the granule, the number of both adults and nymphs of the aphid were counted periodically.

3. Efficacy of Acetamiprid Uncontrolled-Release Granule with Some Application Methods and Watering Volumes

Three- to 4-leaf stage seedlings of cucumber raised in a 9 cm-diameter plastic pot stuffed with Kannami soil, which is sandy loam containing 0.1% organic matter, were prepared for the experiment. These seedlings were transplanted to the field in the plastic house after inoculated with 10 adults of the cotton aphid. The uncontrolled-release granules including 1% acetamiprid were used for planting hole and soil-surface application tests. As for planting hole application, the granules were applied uniformly in a hole, which was dug 10 cm in diameter and 5 cm deep, or at the center of the hole. In case of soil-surface application, the granules were applied on a circle with the radius of 5, 10 or 20 cm around the foot of cucumber after the seedling was transplanted. Watering volume was regulated 2 liter/every 2 days/plant as high-volume plot and 0.5 liter/every 2 days/plant as low volume one after transplanted. The number of aphids infested on the seedling of cucumber was counted on 7, 14 and 21 days after the application. Each test was replicated 4 times. The experiment was conducted at the Haibara Agricultural Research Laboratory of Nippon Soda Co., Ltd., in December, 1990.

4. Efficacy of Controlled-Release Granule of Acetamiprid Affected by Some Watering Volumes and Soil Kinds with Planting Hole Application

One-leaf stage seedlings of cucumber which were raised using a plastic pot of 9 cm in diameter, were provided. The seeds were sown in Kannami and Fujisawa soils, which are clay loam containing 0.1% and 7.2% of organic

matter respectively, and the seedlings were transplanted to the corresponding soils in the planting pot of 18.6 cm in diameter when they grew up to one-leaf stage. These pots were kept in a glass house. The granules including 2% of acetamiprid were applied uniformly in the hole as planting hole application. The watering volume was regulated to 200, 400 and 800 ml/every 2 days. Fifteen adult aphids were infested on the second true leaf on 8, 16 and 21 days after application, and the efficacy was evaluated 5 days after infestation. Each test was replicated 4 times. The experiment was conducted at the Haibara Agricultural Research Laboratory in February, 1991.

5. Efficacy of Acetamiprid Controlled-Release Granule in Soil-Surface Application

One- to two-leaf stage seedlings of cucumber which were raised using a plastic pot of 9 cm in diameter with Kannami soil were provided. The controlled-release granules including 2% of acetamiprid were used. The granules were applied on a circle with the radius of 5, 10 or 20 cm around the foot of cucumber after the seedling was transplanted. The watering volume was regulated to 10 mm/day for 30 minutes. The number of aphids infested on cucumber was counted on 7, 14, 21 and 28 days after the application. The experiment was conducted at the Haibara Agricultural Research Laboratory in July, 1992.

RESULTS AND DISCUSSION

1. Efficacy of Acetamiprid Uncontrolled-Release Granule with Some Application Methods and Watering Volumes

With planting hole application, 0.5 g of acetamiprid 1% containing uncontrolled-release granule showed excellent efficacy against the cotton aphids even on the 21st day after application in both cases when the granules were applied uniformly in the hole and at the center of the hole. From the results of this trial, it was considered that the granule showed excellent efficacy by application at the center of hole as well as uniformly in the hole.

In case of soil-surface application, the granule exhibited higher activity against the aphid as the distance between the treated point and the foot of the seedling became shorter on circles with the radius of 5, 10 and 20 cm from the foot of seedling. This result suggests that

the active ingredient released from the granule in the 20 cm plot moved further than the area of the root elongation (Fig. 2).

Next, the effect of the watering volume on the activity was examined. With planting hole application, the activity in lower watering-volume plots was higher than that with higher watering one. The result shows that the active ingredient released from the granule with higher watering-volume plots moved further behind the range the root can absorb than with lower-watering plots, within watering-volumes designed in the experiment. In other words, with higher watering-volume plots the active ingredient was not properly released to perform the activity against the cotton aphids in an early period after

Fig. 2 Efficacy of 0.5 g acetamiprid 1% containing uncontrolled-release granule against the cotton aphid by various application methods.

—●—: planting hole application A, —■—: planting hole application B, —△—: soil-surface application A, —□—: soil-surface application B, —○—: soil-surface application C, ····×···: untreated control.

Planting hole application A: applied granule uniformly in a planting hole, planting hole application B: applied granule at the center of a planting hole, soil-surface application A: applied granule on the circle with the radius of 5 cm around the foot of seedling, soil-surface application B: applied granule on the circle with the radius of 10 cm around the foot of seedling, soil-surface application C: applied granule on the circle with the radius of 20 cm around the foot of seedling.

treatment and the active ingredient seemed wasted because the half-life of acetamiprid in soil is shorter.¹¹⁾ Higher watering-volume seems advantageous for giving the activity depending on the level of watering-volume adopted. However, the activity with the lower watering-volume plots was superior in this trial. On the other hand, with soil-surface application the activity against the aphids was inferior to that with planting hole application. It is supposed that the active ingredient moved horizontally further behind the area the root can absorb, by the short time watering. And the lower watering-volumes seemed insufficient for the activity of the granule (Fig. 3).

2. Efficacy of Controlled-Release Granule of Acetamiprid with Some Watering Volumes and Soil Kinds by Planting Hole Application

Influence of the watering volume and the soil kind on the activity against the cotton aphids with planting hole application was examined. The dosage of acetamiprid

Fig. 3 Efficacy of 0.5 g acetamiprid 1% containing uncontrolled-release granule in some application methods and watering volumes against the cotton aphid.

—●—: planting hole application A, high-volume watering; —■—: planting hole application A, low-volume watering; —△—: soil-surface application B, high-volume watering; —◇—: soil-surface application B, low-volume watering; ····×···: untreated control.

Planting hole application A: applied uniformly at a planting hole, soil-surface application B: applied on the circle at 10 cm apart from the seedling.

Table 2 Influence of watering volume and the soil kind on the activity of acetamiprid 2% containing controlled-release granule in planting hole application of cucumber by pot test.

Compound	Watering volume (ml / 2 days)	Number of aphids /plant					
		Kannami Soil			Fujisawa Soil		
		8*	16	21	8	16	21
Acetamiprid	200	0	0	0	1	0	0
2%G	400	6	14	6.5	2.5	0.5	3
0.1 g/plant	800	1.5	50	40	1	6	4.5
Untreated	400	51	102.5	126	113.5	105	150

*: days after application.

Table 3 Efficacy of acetamiprid 2% containing controlled-release granule against the cotton aphid on cucumber in soil-surface application.

Compound	Dosage g/plant	Distance* ¹ (cm)	Number of aphids/plant				
			0* ²	10	14	21	28
Acetamiprid 2%G	1	5	0	0	0	2.7	0
		10	0	0.7	0	0	0
		20	0	2.0	26.3	40.3	51.3
Acephate 5%G	2	5	0	0.7	18.0	75	29.0
		10	0	1.7	7.0	48.7	21.0
		20	0	15.7	149.7	166.3	89.7
Benfuracarb 5%G	2	5	0	0	3.0	15.0	109
		10	0	1.0	0	1.3	0.3
		20	0	7.0	54.7	3.0	5.0
Untreated			0	6.0	66.7	233.7	157.7

*¹: Distance between the applying site and the foot of plant. *²: Days after application.

was designed to 0.1 g/plant to compare the efficacy among plots because higher dosage was predicted to exhibit perfect efficacy in all application plots. It is revealed that lower watering-volume with Kannami soil plots exhibited superior efficacy in the levels of 200, 400 and 800 ml per pot, and the efficacy with the 800 ml watering plot was insufficient. On the other hand, the difference in efficacy among the plots of Fujisawa soil was slight. In addition, the efficacy with the 800 ml plot of Fujisawa soil was superior to that of Kannami soil. The efficacy of higher watering volume plots of Kannami soil was inferior to that of Fujisawa soil. This difference in efficacy was supposed to be due to the fact that the moved distance of active ingredient in Kannami soil was longer than that in the Fujisawa soil, since Kannami soil is sandy loam containing 0.1% organic matter and Fujisawa soil is clay loam containing 7.2% organic one (Table 2).

3. Efficacy of Acetamiprid Controlled-Release Granule with Soil-Surface Application

In the former experiment, it was revealed that the efficacy of acetamiprid uncontrolled-release 1% granule in soil-surface application declined as the distance between the foot of seedling and granule treating site became longer. Moreover the efficacy of acetamiprid 2% controlled-release granule in soil-surface application was compared with standard insecticides. The result showed that the efficacy of both acetamiprid 2% granule 1 g/plant and acephate 5% granule 2 g/plant with the 5 and 10 cm plots was superior to those with the 20 cm plot. The controlled-release granule showed the same order in efficacy as the uncontrolled-release one. On the other hand, the efficacy of benfuracarb 5% containing granule 2 g/plant with the 5 and 10 cm plots was superior to that with the 20 cm plot in an early period of test, but was reversed afterward (Table 3). These results are able to be analyzed from a view point of the physical properties

of the compounds. The solubility in water is 4250 ppm for acetamiprid, 650,000 ppm for acephate and 8 ppm for benfuracarb. The active ingredients released from the granules of acetamiprid and acephate, which possessed rather higher solubility in water, moved to the area where the root could absorb them even in case of applying the granule at 5 cm apart from the plant. On the other hand, for benfuracarb whose solubility in water is low, the active ingredient from the granule applied at 5 cm from the plant was not enough to exhibit the efficacy 21 days after application even when it showed efficacy in an early period. And the granule of benfuracarb, when treated at 20 cm apart from the plant, showed efficacy 21 days after the application. It seems that the root of cucumber elongated behind the area where the active ingredient was released from the granule in the plot of 5 cm.

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要 約

アセタミプリド粒剤の各種施用法によるキュウリ寄生ワタアブラムシに対する効力

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アセタミプリドの非徐放性粒剤についてキュウリ寄生ワタアブラムシに対する植穴処理における処理方法の違いによる効力を比較したところ, 粒剤を植穴に均一に処理しても, また植穴の中心にのみ処理してもほぼ同等の効力を得た。土壌表面処理では株元から粒剤処理位置までの距離が5, 10, 20 cm 範囲では, その距離が短いほど高い効力があっ

た。この傾向は徐放性粒剤でも同様であり, 対照薬剤との比較では, アセフェートと同様であった。一方, ベンフラカーブでは処理20日以降では処理位置5 cm に比べ20 cm のほうが優り, 前述の2薬剤とは傾向を異にした。これは, 薬剤の水溶性の違いによる土壌中での移動の差によるものと考えられた。灌水量と効力の関係は, 植穴処理(植え穴に粒剤を均一に処理)および土壌表面処理(株元から10 cm の位置に円状に処理)について多灌水区, 少灌水区を設けて効力を検討したところ, 植穴処理では少灌水区>多灌水区, 表面処理では多灌水区>少灌水区で, 総じて植穴処理>土壌表面処理であった。植穴処理の多灌水区のアブラムシに対する効力が少灌水区のそれに劣ったのは, 粒剤から溶出した原体成分が根から吸収できる範囲外へも移動してしまったためと考えられた。さらに, 徐放性粒剤を用いて, 灌水量, 土壌の違いによる効力の温室内ポット試験結果から, 土壌の違いにより灌水量と効力の関係が異なることが判明した。