[SHORT COMMUNICATION]

Suitable Host Plant and Optimum Initial Ratios of Predator and Prey for Mass-rearing the Predatory Mite, *Neoseiulus longispinosus* (Evans)

Manita KONGCHUENSIN¹*, Vatana CHARANASRI¹ and Akio TAKAFUJI²

¹*Plant Protection Research and Development Office, Department of Agriculture, Bangkok 10900, Thailand*

²*Graduate School of Agriculture, Kyoto University, Kyoto 606-8502, Japan*

(Received 24 July 2006; Accepted 23 September 2006)

Key words: *Neoseiulus longispinosus*, Phytoseiidae, mass-rearing, host plant

INTRODUCTION

For the biological control of spider mites, predatory phytoseiid mites are the most reliable biological agent (McMurtry and Croft, 1997). However, the mass-rearing of predatory mites is a complex matter because it requires the maintenance of stable tri-trophic systems comprised of the predators, their prey and the host plants of the prey.

There are several previous studies on the mass-rearing of phytoseiid mites. McMurtry and Scriven (1965, 1975) reported the mass-rearing technique of *Phytoseiulus persimilis* (Athias-Henriot) with *Tetranychus urticae* Koch on artificial substrates (arenas). After some modifications of the technique, many phytoseiid species, in particular those feeding on pollen have been successfully reared on the arenas. These include *Phytoseius macropilis* (Banks), *Typhlodromus occidentalis* Nesbitt, *T. pyri* Scheuten, *Amblyseius fallacis* (Garman), *A. potentillae* (Garman), *A. cucumeris* (Oudemans) (Overmeer, 1985). Hoy et al. (1982) developed two methods for large-scale rearing of *T. occidentalis* using *T. urticae* as prey on pinto beans and soybeans in the fields. Shih (2001) succeeded in developing an automatic mass-rearing system of *Neoseiulus* (= *Amblyseius*) *womersleyi* Schicha using *T. urticae* plus pollen as food on a bakelite arena.

N. longispinosus (Evans) is an indigenous phytoseiid mite in Thailand, and is considered to be an effective natural enemy for suppressing spider mites, such as *T. urticae* (Kongchuensin et al., 2001) and *Eotetranychus cendanae* Rimando (Thongtub et al., 2001). However, no technique for mass-rearing of this species has been reported previously. A preliminary study showed that this predator cannot be reared with pollen but can be easily mass-reared on detached mulberry leaves with the mulberry red mite, *T. truncatus* Ehara as prey (Kongchuensin et al., 1989). However, for the purpose of release *N. longispinosus* should be mass-reared on host plants suitable for rearing the prey mites in greenhouses or in the fields (Hoy et al., 1982). In addition, for mass-rearing of the predatory mites the optimum ratio of predator:prey for release needs to be decided, in order to harvest the

* Corresponding author: e-mail: manita@doa.go.th; phone: +66-2-579-4128; fax: +66-2-940-5396

maximum number of predators as quickly as possible (Overmeer, 1985). Therefore, the specific aim of this study was to select host plants suitable for mass-rearing of the prey mite, *T. truncatus* and to determine the initial predator:prey ratio appropriate to harvest the largest number of individuals of *N. longispinosus* in a greenhouse.

MATERIALS AND METHODS

Mass-rearing of T. truncatus on 3 bean species

T. truncatus used in this study was collected from cassava plants (*Manihot esculenta* Crantz) in Bangkok in October 1995. We reared them as a stock culture on detached mulberry leaves (*Morus alba* L.) placed upside down on soaked cotton wool on a 25×30 cm tray. Twenty trays for the stock culture were kept in the laboratory at 27–29°C; 60–80% RH; 14D:10L of fluorescent light (40 Lux).

To determine suitable host plants for mass-rearing of *T. truncatus*, population increase rate on three species of bean plant commonly grown in Thailand: mung bean; *Vigna radiata* (L.), cowpea; *V. unguiculata* (L.) and soybean; *Glycine max* (L.) were examined in a screening-net greenhouse (11×20 m) at 32–37°C (temperatures in daytime). Thirty bean seeds were planted in a germination plastic bag (14 cm dia.) with mixed soil (Sida®). Six bags were kept together in a plastic basket (32×45×20 cm), 21 baskets for each bean species. Each of the four legs of the baskets was set in a bowl of water to prevent the dispersal of spider mites among baskets. Three weeks later, 700 adult females (100 from each of seven 2.5×2.5 cm detached mulberry leaves) of *T. truncatus* were taken from the stock culture and inoculated randomly on the leaves of the bean plants in each basket.

The number of individuals at all stages of *T. truncatus* (excluding eggs) occurring on each of the 3 bean plant species were counted at 1 and 2 weeks after inoculation. We collected 25 bean leaflets per basket for each bean plant and counted the number of *T. truncatus* on each leaflet under a binocular microscope. Since the size and the number of leaflets differed among the bean species, one plant per basket was also randomly sampled to count the total number of *T. truncatus* on the whole plant. The differences in the number of *T. truncatus* among the 3 bean species were analyzed by the Tukey-Kramer test.

Optimum initial ratio of predatory mite: prey for maximum yield of the predator

To determine the optimum initial ratio of predator:prey for attaining the best harvest of *N. longispinosus*, cowpea, one of the good host plants for mass-rearing of *T. truncatus* as found from the previous study, was used in this experiment. *T. truncatus* used in this study was from the same stock culture as mentioned above. *N. longispinosus* was collected from yard-long bean; *Vigna sesquipedalis* (L.) at Ratchaburi Province, Thailand in December 1995 and reared on mulberry leaves placed on soaked cotton wool with *T. truncatus* as prey in plastic trays (25×30 cm) and was maintained in the same conditions as those for *T. truncatus*.

Cowpea seeds were planted in baskets in the same manner as described above. Thirty-five bean baskets were prepared and placed inside a greenhouse (32–37°C). The treatments consisted of 6 different initial release ratios of predator:prey. When bean plants were 3 weeks old, we transferred 1,000 adult female *T. truncatus* onto each bean basket in the same manner as described above (100 females onto 10 mulberry leaves for each basket). One day

later, we transferred 100, 50, 33, 25, 20 or 17 adult females of *N. longispinosus* from the stock culture onto each basket. Thus, 6 different initial ratios of predator:prey (1:10, 20, 30, 40, 50 and 60) were examined for mass-rearing of *N. longispinosus*.

One and two weeks after inoculating the host plants with predators and prey, the number of predatory mites occurring on the host plants was examined. We randomly sampled 25 leaflets per basket. The numbers of all stages (except eggs) of *N. longispinosus* and *T. truncatus* on each leaflet were counted under a binocular microscope. Differences in the number of *N. longispinosus* and that of prey with different inoculation ratios were analyzed by the Tukey-Kramer test.

RESULTS

Mass-rearing of *T. truncatus* on 3 bean species

Fig. 1 illustrates the average number of *T. truncatus* per leaflet (A) and that per plant (B) after inoculation for each of the 3 bean species. Two weeks after inoculation, the number of *T. truncatus* on cowpea was higher than that of the other two, although there was no significant difference ($p>0.05$) either in the number of mites per leaflet or per plant among

Fig. 1. Number of *T. truncatus* (all stages inclusive except eggs) per leaflet (A) and that per plant (B) ($\bar{x} \pm \text{S.E.}$, $n=7$) 1 and 2 weeks after inoculation. Bars with the same letter are not significantly different ($p>0.05$; Tukey-Kramer test).

Fig. 2. Number of adult female *T. truncatus* per leaflet ($\bar{x} \pm \text{S.E.}$, $n=7$) 1 and 2 weeks after inoculation. Bars with the same letter are not significantly different ($p>0.05$; Tukey-Kramer test).

the 3 different bean plants. However, the number of adult female *T. truncatus* per leaflet was significantly higher ($p<0.05$) on mung bean and cowpea than on soybean both after 1 and 2 weeks (Fig. 2). These combined results showed that mung bean and cowpea were more suitable than soybean for mass-rearing of *T. truncatus*.

Optimum initial predatory mite:prey ratio

Fig. 3 shows the number of *N. longispinosus* (all stages inclusive except eggs) on cowpea 1, 2 and 3 weeks after inoculation with various initial predator:prey ratios. One week after inoculation, the number of *N. longispinosus* was significantly higher ($p<0.05$) at the 1:10 ratio than in other ratios. Two weeks after inoculation, the number of predators greatly increased. The number of predators was significantly larger at 1:20, 1:30, or 1:40 ratios than that at 1:10 or 1:60 ratios, and the numbers at 1:50 ratio showed intermediate value. Three weeks after inoculation, the number of *N. longispinosus* decreased to very low levels for all ratios, and there was no significant difference between the ratios. These results indicated that the optimum initial predator:prey ratio to obtain the largest number of *N. longispinosus* would be 1:20–1:40.

DISCUSSION

Our study revealed that *T. truncatus* could be mass-reared on mung bean, cowpea and soybean plants. However, we found the number of adult females per leaflet produced on mung bean and on cowpea to be larger than that on soybean. This finding implied that mung bean and cowpea should be more suitable as the host for mass-rearing of *T. truncatus* than soybean. It is known that females of tetranychid mites produce more female offspring on hosts of better quality, which will lead to a higher rate of population increase (Wrensch and Young, 1975, 1978).

The results of the present study showed that the optimum ratio for the best harvest of *N. longispinosus* on cowpea was 1:20 to 1:40. These values are quite similar to those reported by Hoy et al. (1982) who mass-produced *T. occidentalis* with *T. urticae* as prey on pinto bean plants and found the suitable initial predator: prey ratio to be 1:20 to 1:40.

Fig. 3. Number of *N. longispinosus* per leaflet ($\bar{x} \pm \text{S.E.}$, $n=5$) after 1, 2 and 3 weeks of introduction with various initial ratios of predator and prey, on cowpea. Bars with the different letters are significantly different ($p < 0.05$; Tukey-Kramer test).

This study also revealed that the best harvesting time of *N. longispinosus* would be 2 weeks after inoculations. Three weeks after inoculation, the physiological condition of the bean plants seriously deteriorated due to heavy mite injury, and as a result, the prey left the host plants, followed by reduction in the numbers of the predator.

ACKNOWLEDGMENT

This study was supported in part by a Ronpaku Fellowship (NRCT-10421) to M. K. and Grant-in Aid (Basic Research B; No. 17380034 to H. Amano), both from Japan Society for the Promotion of Science.

REFERENCES

- Hoy, M. A., D. Castro and D. Cahn (1982) Two methods for large scale production of pesticide-resistant strains of the spider mite predator *Metaseiulus occidentalis* (Nesbitt) (Acarina, Phytoseiidae). *Zeitschrift für Angewandte Entomologie*, 94: 1–9.
- Kongchuensin, M., V. Charanasri, C. Saringkapibul and T. Kulpiyawat (1989) Biology of the two-spotted spider mite, *Tetranychus urticae* Koch and its predatory mite, *Amblyseius longispinosus* (Evans) on strawberry. *Entomology and Zoology Gazette*, 11: 195–204. (In Thai)
- Kongchuensin, M., V. Charanasri, T. Kulpiyawat and P. Khantonthong (2001) Biological control of two-spotted spider mite in strawberries by the predatory mite, *Amblyseius longispinosus* (Evans) (Acari: Phytoseiidae). In: *Acarology: Proceedings of the 10th International Congress*. (eds., Halliday, R. B., D. E. Walter, H. C. Proctor, R. A. Norton and M. J. Colloff), pp. 513–517, CSIRO Publishing, Melbourne.
- McMurtry, J. A. and G. T. Scriven (1965) Insectary production of phytoseiid mites. *Journal of Economic Entomology*, 58: 282–284.
- McMurtry, J. A. and G. T. Scriven (1975) Population increase of *Phytoseiulus persimilis* on different insectary feeding programs. *Journal of Economic Entomology*, 68: 319–321.
- McMurtry, J. A. and B. A. Croft (1997) Life-styles of phytoseiid mite and their roles in biological control. *Annual Review of Entomology*, 42: 291–321.
- Overmeer, W. P. J. (1985) Rearing and handling. In: *Spider mites 1B*. (eds., Helle, W. and M. W. Sabelis), pp. 161–169, Elsevier, Amsterdam.
- Shih, C. I. T. (2001) Automatic mass-rearing of *Amblyseius womersleyi* (Acari: Phytoseiidae). *Experimental and Applied Acarology*, 25: 425–440.
- Thongtub, T., A. Chandrapatya and G. T. Baker (2001) Biology and efficacy of the predatory mite, *Amblyseius longispinosus* (Evans) (Acari, Phytoseiidae) as a biological control agent of *Eotetranychus cendanai* Rimando (Acari, Tetranychidae). *Journal of Applied Entomology*, 125: 543–549.
- Wrench, D. L. and S. S. Y. Young (1975) Effects of quality of resource and fertilization status on some fitness traits in the two-spotted spider mite, *Tetranychus urticae* Koch. *Oecologia (Berl.)*, 18: 259–267.
- Wrench, D. L. and S. S. Y. Young (1978) Effects of density and host quality on rate of development, survivorship, and sex ratio in the carmine spider mite. *Environmental Entomology*, 7: 499–501.