Farmers can get more sustainable profit from rice-bitter gourd cropping system using the environment-friendly net bagging technique, supplemented with minimal insecticide application. Hence, intensive campaign for the adoption of net bagging of bitter gourd fruit to reduce production cost, minimize health hazards due to insecticide application and increase productivity is urgently needed and strongly recommended.

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MASS REARING OF *Tetranychus truncatus* Ehara (TETRANYCHIDAE, ACARINA) ON WATER HYACINTH, *Eichornia crassipes* L.

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ABSTRACT

A laboratory technique for mass rearing the truncate red spider mite, *Tetranychus truncatus* Ehara, is presented.

The technique is easy, simple and convenient to use. It makes use of water hyacinth (*Eichornia crassipes* L.) for oviposition and feeding, plastic bucket for holding the water hyacinths, rectangular plastic vat with water as moat and tap water to keep the water hyacinths fresh. An average of 4,162 eggs, 1,414 active stages, 1,003 female adults, and 200 male adults per leaf can be produced by about 100 females after two weeks of continuous rearing on water hyacinth.

Key words : spider mites, phytoseiid mites, water lily, tetranychoid mites

Abbreviations : CLSU - Central Luzon State University, NCPC - National Crop Protection Center, UPLB - University of the Philippines Los Baños

INTRODUCTION

The truncate red spider mite, *Tetranychus truncatus* Ehara, is one of the most polyphagous and most widespread of known spider mites in the Philippines (Corpuz-Raros, 1989). It has been recorded on 21 host plants in the Philippines (Rimando 1962; Corpuz-Raros 1989) and 32 host plants in Southeast Asia (Baker 1975). Its recorded Philippine hosts include *Amaranthus spinosus, A. tricolor, Abelmoschus esculentus, Allium cepa, Brassica pekinensis, Cucurbita maxima, Dahlia variabilis, Datura alba, Dolichos lablab, Impatiens balsamina, Moringa oleifera, Oryza sativa, Phaseolus lunatus, Pisum sativum, Psophocarpus tetragonolobus, Sambucus* sp.,and *Solanum melongena.* Recently, it was observed infesting muskmelon grown in the greenhouse of Central Luzon State University (CLSU), Science City of Munoz, Nueva Ecija and recorded for the first time in the Philippines on hosts *Eichornia crassipes* and *Calotropis gigantea.*

The senior author first collected *T. truncatus* from *E. crassipes* growing in a cooking vessel (a landscape material) at Batong Malake, Los Baños, Laguna. To start rearing, infested leaf of water hyacinth seedling growing in the cooking vessel were brought to the laboratory and infested on potted plants. Later, a pure culture was maintained inside the laboratory on the same host plant, grown in plastic bucket on moat of water. Some specimens were inoculated on potted *C. gigantea* where colonies got readily established. A hedge of this ornamental plant grown at the side of the National Crop Protection Center (NCPC), Pili Drive, University of the Philippines Los Baños (UPLB) campus, College, Laguna, was subsequently found naturally infested by the spider mite. Thousands of eggs, immatures and adults were observed on the lower leaves of the two host plants, which yellowed and fell off prematurely.

T. truncatus is potentially serious on several cultivated crops. Heavy infestation on garlic alarmed farmers in Ilocos Norte (Corpuz-Raros 1989) as it did on experimental potted rice plants at the International Rice Research Institute, Los Baños, Laguna in the late 1990s, and the recent infestation of muskmelon at CLSU. It is an emerging pest of chrysanthemums, other ornamentals, and naturally colonizes roses in the greenhouse. However, it is an excellent prey for predatory phytoseiid mites like *Amblyseius longispinosus* (Evans) that are amenable to laboratory mass—rearing only on natural prey spider mites and not on factitious prey acarids. Comparing *T. truncatus* and *T. kanzawai* Kishida as prey for *A. longispinosus,* De Leon-Facundo and Corpuz-Raros (unpublished data) showed no difference in predator development and reproduction, but significantly fewer *T. truncatus* eggs, which are relatively bigger, were required to support production of an egg of the predator. The authors who used soybeans as host plant for rearing both spider mites, indicated that mass rearing of *A. longispinosus* would be more practical with the use of *T. truncatus* as prey.

T. truncatus has been reared and maintained for over one year in the Biological Control Laboratory of NCPC on *E. crassipes*, an excellent host plant for mass—rearing of this spider mite in the laboratory. A mass—rearing technique was devised to produce a continuous supply of this spider mite for experiments on functional response, life history, feeding preferences, among others, that are needed in biological control utilizing predatory phytoseiid mites. This paper presents data on development and population build-up on water hyacinth and other host plants, as well as laboratory method for individual and mass-rearing of the mite.

MATERIALS AND METHODS

Selection of host plants

Preliminary trials with various natural host plants were made to find suitable hosts for large-scale production of *T. truncatus.* Suitability of a host was based on its availability, ease of propagation and maintenance, and its acceptance to the mite as manifested by the mite's readiness to settle and reproduce. Eight host plants, namely, *Arachis pintoi, C. gigantea, Carica papaya, Chrysanthemum* cv., *Chrysanthemum* sp. (putu-puto), *E. crassipes, Glycine max,* and *S. melongena,* were evaluated for their suitability as hosts in the mass culture of the truncate mite. Leaves of the new host plants were inoculated with mites by contact with infested leaf of an on-going culture on water hyacinth. Upon wilting of the old leaf, the mites transferred to the new hosts and settled there. They were allowed to reproduce on each host for two weeks after which 10 leaves per host plant were selected

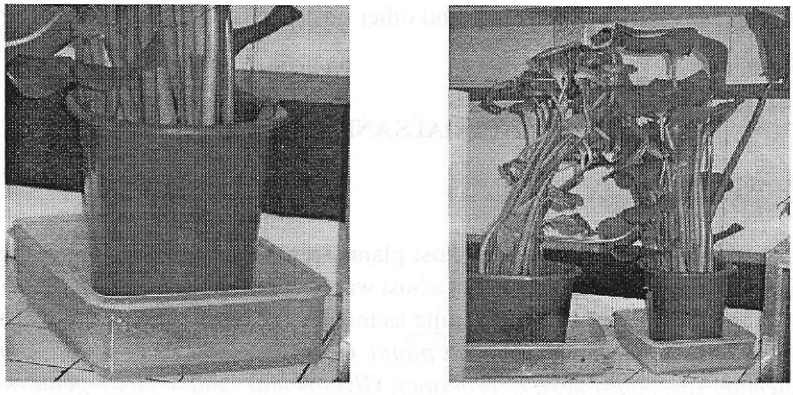
at random, detached, and placed separately in zip-lock plastic bags. The eggs, active immatures, adult males and females were counted and recorded per leaf. Since the host plants differed in size, the surface areas of the leaf samples were measured with a leaf area meter and the density per cm^2 was computed from the number of mites per leaf.

Mass culture of *T. truncatus*

Rearing unit. Commercially available 5L buckets were used to contain the host plants. Each bucket was filled with tap water and placed on a moat of water on a rectangular vat to ward off ants and predators from invading the culture (Fig. 1a).

Method of infesting the host. Two methods of infesting the host were used. The first, employed initially, consisted of transferring gravid females individually onto a new host with a fine camel's hair brush. The second, used when spider mite population became dense, was by contact where a whole infested leaf or pieces of it were clipped on a new host.

Mass rearing procedure. Gravid females of *T. truncatus* maintained on potted water hyacinth were collected and transferred with a pointed fine camel's hair brush to fresh water hyacinths in a bucket mounted on a moat of water in a large vat (Fig. 1b). Observations were taken daily, and after 2 weeks of conditioning in the laboratory, infested leaves were cut and clipped on to fresh water hyacinths. Extra care was observed to ensure that the mites had transferred to the new substrate before the leaves dried up. This was done by securing the infested leaf with a rubber band to the petiole of the fresh substrate. Upon transfer of most of the mites, the dried leaf was removed and the culture was allowed to develop for one week, after which almost all of the leaves became stippled with mite feeding punctures and started to deteriorate. A bucket of fresh water hyacinth was then placed beside the previous one. By the 4^{th} or 5^{th} day, most of the mites had transferred to the new substrate. At this time, the old substrate was removed and discarded properly, and on the 6^{th} or 7^{th} day a fresh substrate was offered again. This process was repeated continuously.



a b

Figures 1(a) Rearing unit for *Tetranychus truncatus* in a moat of water inside a rectangular vat and **(b)** set up for mass rearing *T. truncatus* with the spent host (left) and fresh host (right).

RESULTS AND DISCUSSION

Suitability of host plants tested

Table 1 shows the influence of various host plants on development and reproduction of *T. truncatus* two weeks after inoculating each host plant with 100 female mites. The eight plant species evaluated can serve as host plants since they sustained growth, development and reproduction of the mites. However, *A. pintoi* appeared as the least suitable host for oviposition (8.0 eggs per leaf) while the best was *E. crassipes* (4162.7 eggs per leaf). The former was followed (in increasing egg density) by *Chrysanthemum* sp. (putu-puto), *Chrysanthemum cv*, *C. papaya, S. melongena, C. gigantea* and *G. max*. Egg production on *G. max* , the second best host for oviposition, was 1,060.2 which was only ¼ that on *E. crassipes*. Significant differences were also obtained in densities of active immature stages of the truncate mite on various host plants. The host plants showed almost similar trends except that *Chrysanthemum* cv at 69.5 active immature stages per leaf performed better as the fourth best host. Adult production followed the same trend as that for eggs and active immatures with *A. pintoi* (2.6 adult females) as the poorest, *E. crassipes* (1,003.3 adult females) as the most suitable and *G. max* (615.3 adult females) as next best. Sex ratio varied among host plants, although there was a preponderance of females.

When data per leaf were converted to per cm^2, the same trend was also obtained except that *G. max* produced significantly higher density of active immatures (14.4 per cm^2) and adults (11.51 per cm^2). Comparing the top two hosts, *E. crassipes* and *G. max*, greater number of eggs, active immatures and adults was produced on the former than on the latter which is expected because of greater leaf surface area (113.44 cm^2) of *E. crassipes* for mite reproduction and feeding. The results show *E. crassipes* as an excellent host plant for mass—rearing the spider mites. Its leaves are big, succulent but firm and have long vase-life, qualities which are ideal for supporting a growing population of *T. truncatus* inside the laboratory, with minimum investment

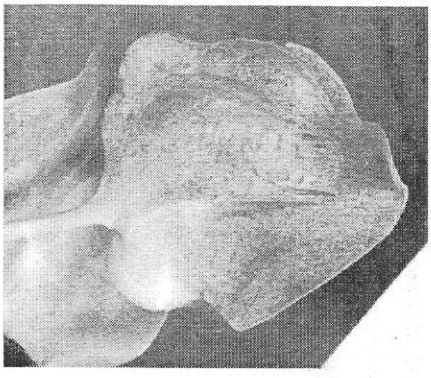


Figure. 2. Stippling or brown feeding punctures of *T. truncatus* on water hyacinth

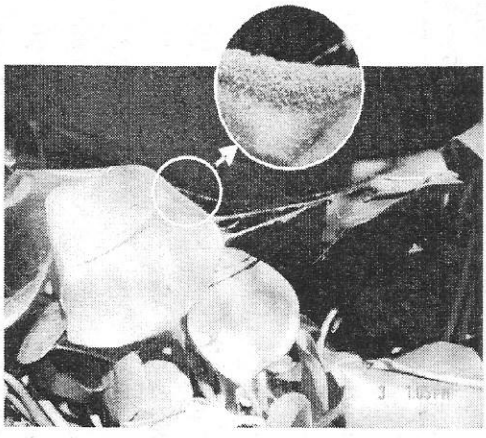


Figure. 3. *T. truncatus* 'ballooning' to fresh substrate using silken threads as bridges. Inset shows a cluster of mites.

Table 1. Mean leaf area of host plants and density of the eggs, active stages and adults of *Tetranychus truncatus* Ehara two weeks after inoculating various host plants with about 100 females per leaf.

Host Plant	Mean leaf area (cm^2)	Density (per leaf)					
		Egg	Active stages	Adult		Total[1]	Sex ratio (Female: Male)
				Male	Female		
Arachis pintoi	11.69	8.0	18.9	1.9	2.6	31.4g	1.37:1
Calotrophis gigantea	75.98	858.2	498.5	103.1	233.2	1,693.0g	2.26:1
Carica papaya	100.97	99.6	27.9	5.5	29.7	162.7g	5.40:1
Chrysanthemum cv	38.95	11.3	69.5	3.5	8.4	92.7g	2.40:1
Chrysanthemum sp.(putu-puto)	23.58	15.7	20.9	2.7	6.8	46.1g	2.52:1
Eichornia crassipes	113.44	4,162.7	1,414.4	200.4	1,003.3	6,780.8g	5.00:1
Glycine max	60.83	1,060.2	748.6	223.1	615.3	2,647.2g	2.76:1
Solanum melongena	90.25	128.5	68.6	16.2	47.2	260.5g	2.90:1

[1] Means followed by a common letter are not significantly different at 5% level of significance.

on labor in changing spent hosts with new ones. It can be obtained for free and readily available because it can multiply untended on a pond. *E. crassipes* is now currently used in mass rearing *T. urticae* and *Oligonychus biharensis* at the Acarology Laboratory, Department of Entomology, UP Los Banos.

Feeding of active immatures and adults

Figure 2 shows the appearance of the leaves of water hyacinth fed upon by the truncate mite. Whitish stipplings appear gradually on fresh substrates but suddenly become numerous once the deutonymphs molt into adults, due to heavy feeding of the latter. Nymphal feeding increases at the deutonymphal stage and food becomes critical for proper growth and development of the mites because well- fed deutonymphs are bigger and develop into larger adults. Larger adults have longer lifespan and higher fecundity.

Nymphs and adults normally congregate at the tips of leaves at high densities. When the substrate has started to deteriorate (Fig.3), the mites used silken threads for dispersal to new hosts. At this time a new bucket of fresh water hyacinth should be nearby to prevent loss due to "ballooning" mites.

SUMMARY AND CONCLUSION

Eight host plants were evaluated for mass rearing the truncate spider mite *T. truncatus*. Leaves of each host plant were infested with 100 female mites and allowed to reproduce for two weeks after which 10 leaves per host plant were randomly selected for counting the mites and measuring leaf area . All host plants used sustained growth, development and reproduction of the mites. *E. crassipes* was the most suitable host plant for oviposition and feeding followed by *G. max* and *C. gigantea.* The least suited host plant was *A. pintoi. E. crassipes,* being a weed, is the cheapest host for mass-rearing *T. truncatus* and other spider mites in the laboratory.

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