

# THE USE OF PREDATORY MITE *PHYTOSEIULUS PERSIMILIS* (ACARI: PHYTOSEIIDAE) IN THE CONTROL OF TWO-SPOTTED SPIDER MITE (*TETRANYCHUS URTICAE* KOCH, ACARI: TETRANYCHIDAE) AT GREENHOUSE CUCUMBER PRODUCTION IN TOKAT PROVINCE, TURKEY

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**Abstract.** The effectiveness of the predatory mite, *Phytoseiulus persimilis* Athias-Henriot (Acari: Phytoseiidae), as a suppressive agent of the two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae), was evaluated on greenhouse cucumber at predator:prey release ratios of 1:5, 1:15, and 1:30. Releases at each predator:prey ratio were made at 30 *T. urticae* densities per leaf. Evaluation was initiated 4 days after the release. On the under side of the leaves which were selected randomly from the lower, middle, and upper parts of the plants, the eggs and active forms of *T. urticae* and *P. persimilis* were counted using 10X hand magnifier for each treatment. In control treatments without predatory mite and acaricide application, population of *T. urticae* was constantly increased and reached 140 active forms/leaf in August. Subsequently the population decreased when the plants died. At ratios of 1:5, *P. persimilis* reached 8 active forms/leaf while *T. urticae* populations reached 11 active forms/leaf. At ratios of 1:15 *P. persimilis* population increased (3.4 active form per leaf) and *T. urticae* population decreased (1.6 active forms per leaf) in September and the latter one was kept by *P. persimilis* at low levels thereafter. Plant damage also was significantly reduced at these densities. *P. persimilis* population decreased when prey (*T. urticae*) population decreased. Our work demonstrates the potential of *P. persimilis* to provide effective control of *T. urticae* on a greenhouse-grown cucumber at a moderately low predator:prey ratio (1:15) in Tokat Province, Turkey.

**Keywords:** predatory mites, biocontrol, cucumber pests, spider mites

## Introduction

Spider mites of the Tetranychidae are major pests of greenhouse cucumber and other agricultural crops worldwide. Foliar damage caused by spider mite feeding causes significant yield loss. To protect these plants from spider mite damage, farmers have traditionally relied on synthetic pesticides to suppress population outbreaks. However, due to resistance of spider mites to pesticides, negative effects of pesticides on natural enemies, and environmental concerns, other control tactics besides pesticides are needed.

An alternative to pesticides for suppression of spider mites is the inoculative release of predatory mites from the family Phytoseiidae. Predatory mites are important biological control agents of spider mites in many agricultural systems. Phytoseiids (*Typhlodromus* spp., *Amblyseius* spp., *Phytoseiulus* spp.) are effective at suppressing two-spotted spider mites in vegetables grown in greenhouse. Predatory mites have a shorter development

periods and active feeding in each period, therefore they are very important biocontrol agents. In recent years, especially greenhouse vegetables and floriculture, as well as the control of the red spider species in the open field, primarily *Phytoseiulus persimilis* and other phytoseiid species have been used (Loginova et al., 1987; Jarasik, 1990; Jarasik and Pliva, 1990; Easterbrook, 1992; Zang and Sanderson, 1995; Boom et al., 2002; Lanzoni et al., 2017). Kim and Park (2006) reported that *Tetranychus urticae* was effectively controlled by the release of predatory mites at a rate of 3 predator/m<sup>2</sup>. Limited studies were conducted in mass production of *P. persimilis* and its use in control of *Tetranychus cinnabarinus* on greenhouse growing strawberries (Kılınçer et al., 1992; Kazak et al., 1992; Öncüler et al., 1994; Kısmalı et al., 1999; Kazak et al., 2002; Çakmak et al., 2005; Çakmak et al., 2007) and cucumber (Kazak et al., 2000) in Turkey. In the study, conducted by Çakmak et al. (2005) reported that when the *T. cinnabarinus* population level reached 2-3 individuals per leaflet in strawberry plants, *P. persimilis* was released once at the rate of 1 predator to 20 prey, the predatory mites provided an effective control 15-20 days after release, and no additional release was needed during the rest of the growing season. At present, mass rearing of predator mite *P. persimilis* is not continued in Turkey. Commercial companies are exporting predator mites from abroad.

Aims of the present study is to assess the effectiveness of the predatory mite *Phytoseiulus persimilis* at controlling two-spotted spider mite (*Tetranychus urticae*) when released into greenhouse growing cucumber plants in Tokat-Turkey.

## Materials and methods

### *Rearing predatory mites*

The stock cultures of *Phytoseiulus persimilis* were purchased from private company (Koppert Biological Systems, Netherland) and reared on the bean plants grown at 25°C and 60% ± 5% relative humidity at 16h:8h (L:D).

### *Screenhouse trial*

The experiment was conducted in Plant Protection Department screenhouse at the Tokat Gaziosmanpaşa University, Tokat. The screenhouse received natural light during the course of the treatment with no artificial light source or climate controls. Coco peat is used for growing cucumber plants (*Figure 1*). Necessary plant essentials were given by water drip system. The average temperature and relative humidity were 26±2°C and 60±5% during the course of the experiment in the screenhouse. Five treatments were evaluated in a randomized complete block design with three blocks and nine plants per replicates. A predator:prey ratio of 1:5, 1:15; 1:30 was calculated for each release. In addition to this, there is a control and acaricide treatment with classical acaricide (Spiromesifen 240 g/l (Oberon SC 240) 50 ml/da) application. Thirty *Tetranychus urticae* young female were placed on individual plants with the aid of a fine-tipped saber brush. Two days after *T. urticae* release, at 1:5, 1:15, and 1:30 ratios 6, 2, and 1 mated young *P. persimilis* female individuals were released (Kazakoğlu et al., 2000). Acaricide was applied at recommended concentration.

Evaluation was performed 4 days after the predatory mite release. Plants were evaluated every four days. In each plot lower, middle and upper parts of randomly selected plants 25 leaves were visually assessed and the number of *T. urticae* and *P.*

*persimilis* motiles and eggs counted with hand-held 10X magnifier to quantify the effect of *P. persimilis* releases on *T. urticae* populations.



**Figure 1.** A view from experiment unit

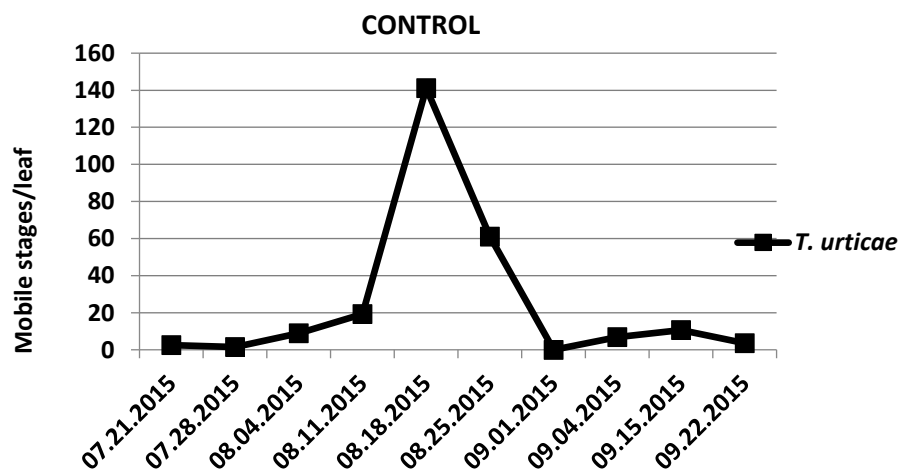
### Statistical analysis

The data were analyzed by the SPSS 17 statistical program (SPSS Inc., 2008) using general linear model to compare the effects of release rates of predatory mites and time on controlling *Tetranychus urticae* at greenhouse conditions. ANOVA was used to compare means and Tukey's test was used to separate means.

### Results

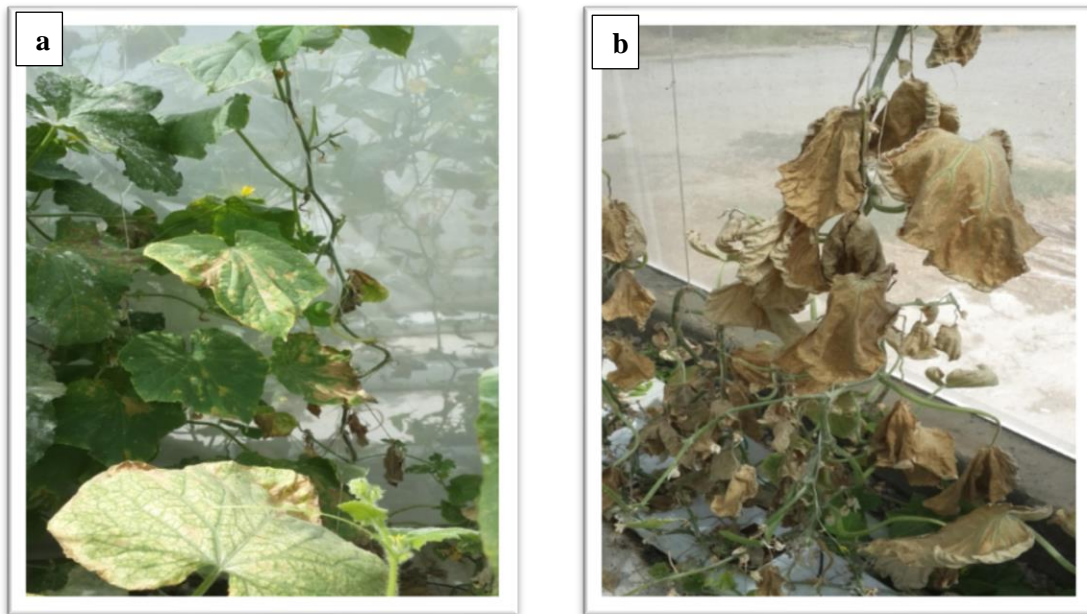
When *Phytoseiulus persimilis* was not released and without acaricide application, the population of *Tetranychus urticae* was constantly increased, and reached a peak of 141.11 motiles per leaf at week 5 and then decreased due to death of the infested cucumber plants ( $F = 3.42$ ;  $df = 4, 64$ ;  $P < 0.05$ ) (Figures 2, 3b).

Two weeks after the predatory mite release, no *P. persimilis* motiles were recorded in the 1/5 predator:prey ratio treatment. However, at week 3 there were an average of 0.96 motiles per leaf ( $F = 29.16$ ;  $df = 4$ ;  $P < 0.001$ ).

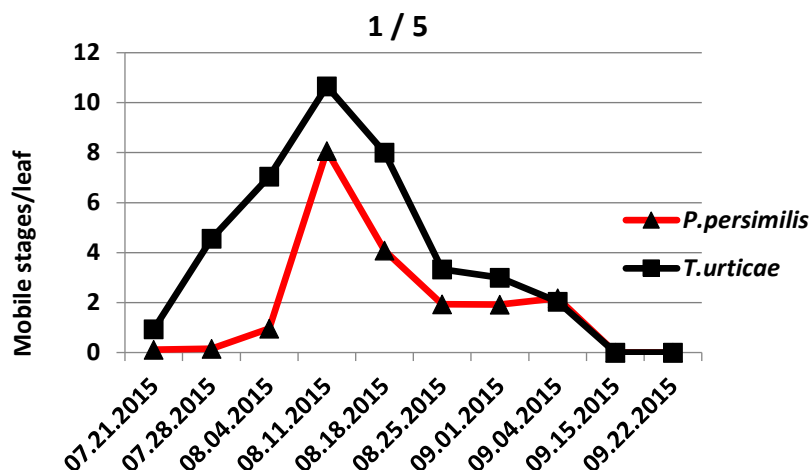


**Figure 2.** *Tetranychus urticae* two-spotted spider mite density in untreated control

This increased to 8.07 motiles per leaf at week 4 ( $F = 10.33$ ;  $df = 4$ ;  $P < 0.001$ ) and declined to 4 and 2 motiles per leaf at week 5 and 6 respectively and then remained at this level for the remaining 2 weeks (*Figure 4*). The parasitic mite *T. urticae* population was followed the same trend with the predator mite. It's population reached at peak of 10.66 motile per leaf at week 4 ( $F = 22.25$ ;  $df = 4$ ;  $P < 0.001$ ) and declined to 3.33 and 2.04 motile per leaf at week 7 and 8, respectively ( $F = 9.92$ ;  $df = 4$ ;  $P < 0.001$ ) (*Figure 4*).



**Figure 3.** a. Cucumber plants in *Phytoseiulus persimilis* released plots b. Damages caused by *Tetranychus urticae* in untreated control plants

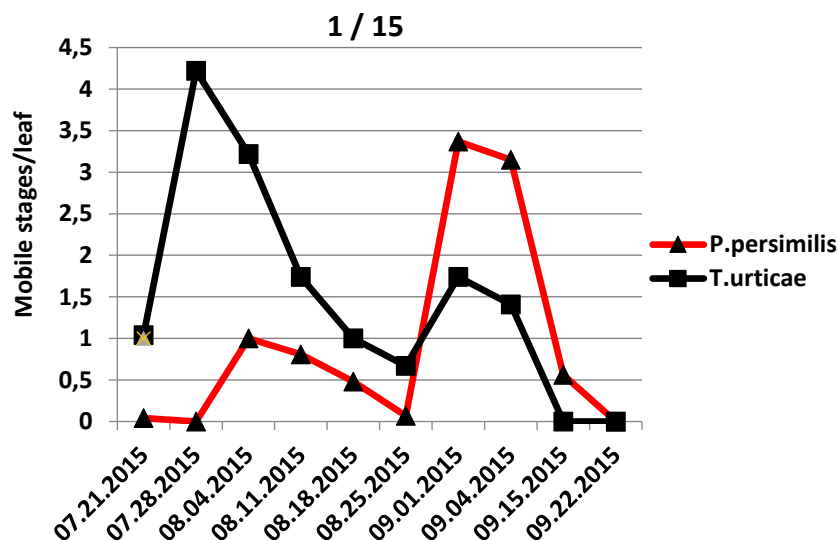


**Figure 4.** *Tetranychus urticae* two-spotted spider mite and *Phytoseiulus persimilis* density at 1/5 predator:prey ratio

*P. persimilis* population density increased with increase in *T. urticae* population and decreased with decrease in prey density. The data demonstrated that releases of *P.*

*persimilis* at a 1:15 predator:prey ratio maintained low *T. urticae* populations (Figure 4). Two weeks after the predatory mite release, no *P. persimilis* motiles were recorded in the 1/15 predator:prey ratio treatment. However, at week 3 there were an average of 1.0 motiles per leaf ( $F = 29.16$ ;  $df = 4$ ;  $P < 0.001$ ). This increased to about 3.5 motiles per leaf at week 7 and declined to 3 and 0.5 motiles per leaf at week 8 and 9, respectively ( $F = 4.88$ ;  $df = 4$ ;  $P < 0.01$ ) (Figure 5).

The parasitic mite *T. urticae* population was followed the parallel trend with the predator mite It's population reached at peak of 4.25 motile per leaf at week 2 ( $F = 22.11$ ;  $df = 4$ ;  $P < 0.001$ ) and declined to 3.25 ( $F = 6.52$ ;  $df = 4$ ;  $P < 0.01$ ), 1.75 ( $F = 22.11$ ;  $df = 4$ ;  $P < 0.001$ ), 1.0 ( $F = 3.41$ ;  $df = 4$ ;  $P < 0.05$ ) and 0.75 ( $F = 8.59$ ;  $df = 4$ ;  $P < 0.001$ ) motile per leaf at week 3, 4, 5 and 6, respectively. *T. urticae* population reached average of 1.75 motile per leaf at week 7 and declined to 1.41 and 0.0 motile per leaf at week 8 ( $F = 9.91$ ;  $df = 4$ ;  $P < 0.002$ ) and 9, respectively (Figure 5).



**Figure 5.** *Tetranychus urticae* two-spotted spider mite and *Phytoseiulus persimilis* density at 1/15 predator:prey ratio

At 1/30 predator:prey ratio treatment, despite the predator population reached peak of 22.0 motiles per leaf at week 4 ( $F = 10.30$ ;  $df = 4$ ;  $P < 0.001$ ) it did not suppress the population of *T. urticae* which reached average of 40 motiles per leaf at week 4 ( $F = 22.25$ ;  $df = 4$ ;  $P < 0.001$ ) (Figure 6). One week after predatory mite release, no *P. persimilis* motiles were recorded in the *P. persimilis* treatment. However, constant increase of *P. persimilis* observed after first week of release *P. persimilis* did not suppress *T. urticae* population effectively until week 5 (12.37 motiles/leaf) ( $F = 3.42$ ;  $df = 4$ ;  $P < 0.05$ ). *Tetranychus urticae* population declined to average of 7.55 motile per leaf at week 6 ( $F = 8.59$ ;  $df = 4$ ;  $P < 0.003$ ) then continued to decline constantly to 6.9 ( $F = 9.92$ ;  $df = 4$ ;  $P < 0.002$ ), 2.2 ( $F = 6.28$ ;  $df = 4$ ;  $P < 0.01$ ) and 0 motiles per leaf at week 7.8 and 9 respectively (Figure 6).

In the acaricide treatment, *T. urticae* population reached the peak of 2.8 motile per leaf at week 3 ( $F = 6.53$ ;  $df = 4$ ;  $P < 0.01$ ) and declined to average of 0.8 motile per leaf at week 4 ( $F = 22.25$ ;  $df = 4$ ;  $P < 0.001$ ) than increased up to average of 1.95 motile per leaf

at week 5 ( $F = 3.42$ ;  $df = 4$ ;  $P < 0.05$ ). Again the population of *T. urticae* started to decline at week 6 ( $F = 8.59$ ;  $df = 4$ ;  $P < 0.003$ ) (Figure 7).

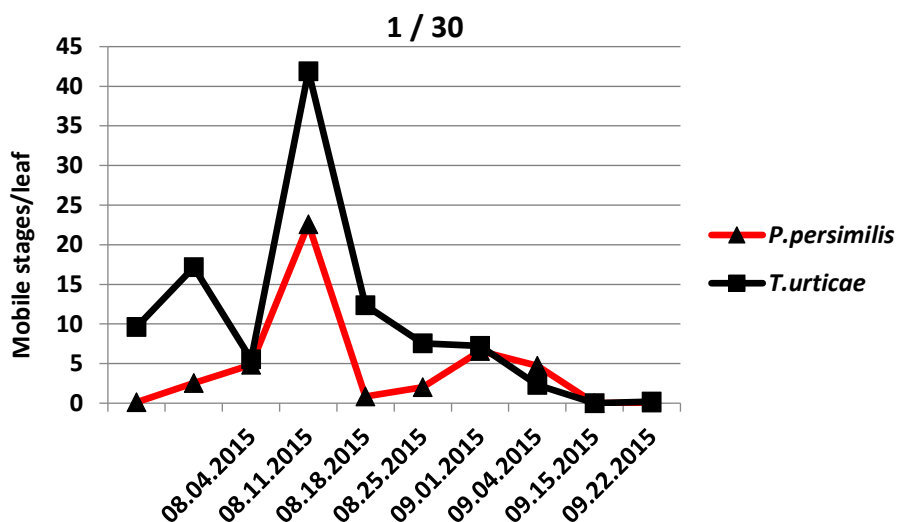


Figure 6. *Tetranychus urticae* two-spotted spider mite and *Phytoseiulus persimilis* density at 1/30 predator:prey ratio

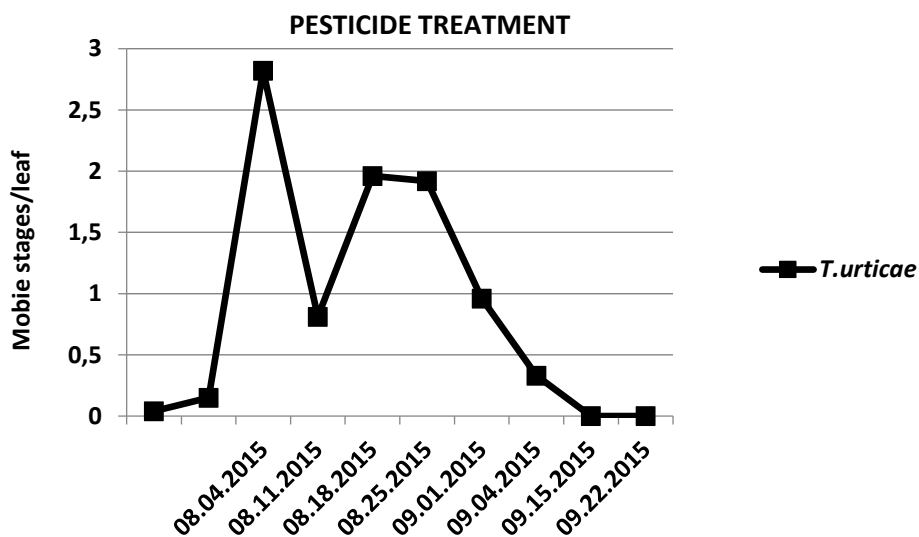


Figure 7. *Tetranychus urticae* two-spotted spider density in acaricide treatment

## Discussion

The natural predator of two-spotted spider mites *Phytoseiulus persimilis* is the most widely used commercial predators for controlling mites. Having shorter development period from one generation to the next provides advantage to *P. persimilis* over the preys. However, the faster development potential of *P. persimilis* is an important factor in its success as a predator, it was reported that the initial ratio of pest to predator determines the outcome of a control program (Griffits, 2000; Lanzoni et al., 2017). Based on the

results of the present study, population of *Tetranychus urticae* increased rapidly in control treatment after week 4. The rapid population growth of *T. urticae* in the control treatment was expected, given the high biotic potential of *T. urticae*. Indeed prevailing conditions in protected cultivation such as greenhouse often favor the development of *T. urticae* (Kim and Park, 2006). The present study indicated that the potential of the predator to reduce the population of *T. urticae* determined by the predator:prey ratios at the time of predator release. At the 1/5 and 1/30 predator:prey ratios, population of *T. urticae* increased, and reached the peak of 10.5 and 40.0 motiles per leaf respectively at week 4. At these two ratios tested *P. persimilis* population increased constantly up to 4<sup>th</sup> week of release and then began to suppress *T. urticae* population significantly ( $p \leq 0.05$ ). On the other hand, population of *T. urticae* reached at peak of 4.25 motile per leaf at week 2 and declined to 3.25, 1.75, 1.0 and 0.75 motile per leaf at week 3, 4, 5 and 6, respectively. *Phytoseiulus persimilis* took to reach control over *T. urticae* was 14 days when the pest:predator ratio is 1/15. The finding of the present study demonstrated that predator:prey ratio was a determinative factor for the effective control of *T. urticae*. This finding is supported by another greenhouse study showed that Predator mite *Anthoseius recki* (Wainstein) (Mesostigmata: Phytoseiidae) suppressed the population of *Tetranychus cinnabarinus* at 1/30 and 1/15 predator:prey ratios effectively. However, at 1/60 predator:prey ratio the predator failed to provide effective control of the prey on strawberry plants (Şekeroğlu, 1984). Scopes (1985) reported that *P. persimilis* took to reach control over *T. urticae* was 16 days when the pest:predator ratio was 1:200, 13 days when it was 1:100, and 11 days when it is 1:50. This clearly demonstrates that early application is more efficient. *P. persimilis* gave effective control of *T. urticae* when it was released onto strawberry with low levels of *T. urticae* infestation in southeast Queensland, Australia (Waite, 1998). Bonomo et al. (1991) also reported that releases of *P. persimilis* gave effective control of *T. urticae* at lower density of it. Similarly Kim (2001) evaluated the effectiveness of *P. persimilis* against *T. urticae* on strawberry in five commercial greenhouses and got an excellent result by releasing the predator at a rate of 3/m<sup>2</sup> in Korea. Spicciarelli et al. (1992) and Boom et al. (2002) recommended that phytoseiid mites give good control of *T. urticae*, if one mite is released per plant when the infestation of *T. urticae* has reached two individuals per leaf, and about 30% of the leaves are infested.

## Conclusion

This study was conducted to see controlling two-spotted spider mites using *P. persimilis* at cucumber plants in screenhouse conditions in Tokat. Our results indicate that when released at 1:15 predator:prey and when *T. urticae* population are low per leaf, *P. persimilis* is able to maintain populations of *T. urticae* below damaging levels throughout a growing season (Figure 3a). It would appear that *P. persimilis* can give good control of two-spotted spider mite on cucumber plants, particularly if the predator is introduced when numbers of *T. urticae* are fairly low. What we do for growers, we arrange field days in the light of experiences and the results are shared with our producers and the stakeholders.

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