

Bifenazate, a Prospective Acaricide for Spider Mite (*Tetranychus urticae* Koch) Control in Czech Hops

JOSEF VOSTŘEL

Hop Research Institute, Co., Ltd., Žatec, Czech Republic

Abstract

VOSTŘEL J. (2010): **Bifenazate, a prospective acaricide for spider mite (*Tetranychus urticae* Koch) control in Czech hops.** Plant Protect. Sci., **46**: 135–138.

Bifenazate, a new selective carbazate acaricide, seems to be a very good substitute for propargite to control spider mites (*Tetranychus urticae* Koch) on hops in the Czech Republic. To investigate the phenomenon of *T. urticae* resistance to this compound, 20 samples of field populations were taken in several Czech and Moravian hop-growing regions in 2006 and 2007 and subjected to laboratory tests in a Potter tower. Low values of C100 M (100% mortality) in comparison with the supposed registered concentration reveal that bifenazate may become a useful acaricide within the anti-resistant strategy against *T. urticae* not only in Czech but also in all European hop-growing regions.

Keywords: two-spotted spider mite (*Tetranychus urticae* Koch); hop (*Humulus lupulus* L.); hop protection; acaricide; bifenazate; resistance; LC₉₀; C100 M; anti-resistant strategy

After the damson-hop aphid [*Phorodon humuli* (Schrank)] the two-spotted spider mite (*Tetranychus urticae* Koch) is the second most dangerous pest of hop in all hop-growing regions in the world. Nowadays, hop protection against this pest is based nearly entirely on the application of acaricides. Quite a short development time ensures six to maximally nine generations during a season, which increases the danger of resistance (MALAIS & RAVENBERG 1992). Under unusually hot and dry weather conditions during June and July of 1976 there occurred outbreaks of two-spotted spider mites, and organophosphorus insecticides were found to become totally ineffective against field strains of *T. urticae* in Czech hop-yards. Since that time a number of acaricides have been used against this pest (VOSTŘEL 1993) as less efficient pesticides were gradually replaced by more effective ones (VOSTŘEL 1996).

For more than 20 years, in the Czech Republic hop protection against two-spotted spider mite in the stage of hop cone formation has been nearly entirely based on the application of propargite as one of the key acaricides. In the years with lower population densities of *T. urticae*, one application of fenpyroximate, hexythiazox or abamectin was usually sufficient to control this dangerous pest (VOSTŘEL 1999). By contrast, in the years with average or high occurrence of *T. urticae*, propargite became the key acaricide and practically the only one that was able to control such high densities of spider mites. Despite its continued effectiveness spider mites have survived after its application in some cases. Hence, despite good efficacy and low resistance factors, in a few years propargite may need to be replaced by a newer acaricide (VOSTŘEL 2009). Laboratory tests show that bifenazate, a new selective carbazate acaricide already in regular use

in Washington and Oregon hops in the USA (JAMES 2002), has a very good efficacy against *T. urticae*. Nevertheless, it has not been registered for use in European hop growing so far. To avoid resistance problems to this compound, as well as to prolong its potential utilisation within an anti-resistant strategy, we established LC_{90} and C100 M values on *T. urticae* strains sampled within Czech and Moravian hop-growing regions. The value LC_{90} means such a concentration of the tested acaricide under which 90% of the tested spider mites are killed, whereas the value C100 M represents 100% mortality of the tested mites. Avoidance and postponing of resistances to pesticides will be an important part of the hop protection system against pests and diseases in Europe in the future (VOSTŘEL & FILKUKA 2008).

MATERIALS AND METHODS

Samples of two-spotted spider mite populations were taken from 20 selected hop-yards in different hop regions in the Czech Republic in 2006 and 2007. Nine field strains were sampled from Žatec region (Louny district), three from Žatec region (Rakovník district), six from Ústěk and two from Moravian Tršice region. Field samples of *Tetranychus urticae* were collected at harvest

time in the third decade of August and cultures set up in the laboratory and their offspring were used in laboratory tests. Spider mites were placed in an air-conditioned room at a temperature of 20–22°C and 16-hour photoperiod and 60–70% RH. Hop seedlings were used as host plants. These plants were grown in a glasshouse throughout the year. Hop leaves were taken from untreated or residue-free hop plants.

The spraying method (HŮRKOVÁ & GESNER 1981) required to place discs of host-plant leaves on moist filter paper in Petri dishes in order to prevent tested spider mites from escaping. Petri dishes were placed at the bottom of Potter tower (30 cm in diameter and 96 cm high) and sprayed with 1.0 ml of a solution of bifentazate (trade name: Acramite 480 SC) using Potter's nozzle under a pressure of 0.2 MPa. A geometric series of six concentrations (0.15%; 0.075%; 0.0375%; 0.01875%; 0.00937%, and 0.00468%) was tested. Treated leaf discs were removed from the sedimentation tower after a sedimentation time of 10 minutes.

Two to three hours after spraying, 25 spider mites were transferred to each of the four discs cut from hop leaves so as to reach a total of 100 mites in each experimental unit. The leaf discs were placed at the bottom of Petri dish 9 cm in diameter using a fine, slightly moistened brush. Moist filter paper was placed at the bottom of the Petri

Table 1. Biological efficiency of bifentazate (Acramite 480 SC) in the control of two-spotted spider mite (*Tetranychus urticae* Koch) in laboratory tests in 2006 and 2007

Tested Strain	Concentration of Acramite 480 SC/mortality (%)						Standard deviation
	0.15	0.08	0.04	0.02	0.01	0.00468	
Žatec region							
Louny district							
2006	100.0	100.0	100.0	100.0	99.1	90.1	3.63
2007	100.0	100.0	100.0	100.0	98.9	89.7	3.79
Rakovník district							
2006	100.0	100.0	100.0	100.0	98.5	89.3	3.93
2007	100.0	100.0	100.0	100.0	97.0	84.0	5.84
Ústěk Region							
2006	100.0	100.0	100.0	100.0	99.0	92.5	2.74
2007	100.0	100.0	100.0	100.0	97.0	84.0	5.84
Tršice region							
2006	100.0	100.	100.0	100.0	98.5	94.0	2.19
2007	100.0	100.0	100.0	100.0	99.0	88.0	4.41

dishes to prevent spider mites from escaping. The tested acaricide was applied in the following sequence: untreated (control) leaves and treated leaves in order from the lowest (0.00468%) to the highest (0.15%) tested concentration. Mortality was counted 48 h after treatment. Spider mites unable to crawl were also recorded among the dead. The mortality on control leaves was not allowed to exceed 20%; if it did so, the test was repeated. Each experiment was replicated three times, hence 300 spider mites were tested under each concentration of bifentazate. Resistance factors (RF) could not be established because the LC_{50} values needed for their determination were exceeded in all six concentrations that were tested. The values of biological efficiency within the individually tested concentrations for the resistant field strains were determined as average values for the individual regions: Žatec, Louny and Rakovník districts, Ústěk and Tršice (Table 1).

RESULTS

The values LC_{90} and C 100 M for bifentazate are presented in Table 1. In terms of average values for each tested concentration, there were no large differences in mortality of *T. urticae* strains sampled from the particular hop-growing regions nor were there any differences between the two years. The lowest tested rate (0.00468%) corresponds with the LC_{90} for *T. urticae* strains originating from the Žatec hop-growing region in 2006. The mortality of *T. urticae* strains sampled from Ústěk and Tršice regions in 2006 was slightly higher at 92.5% and 94.0%, respectively, but these differences were not statistically significant. Laboratory tests for the strains collected in 2007 revealed a slight shift in LC_{90} values, with consistently lower mortalities at the 0.00468% concentration in that year. Nevertheless, the differences are not significant although the values of mortality at the lowest tested rate differed by 6.0% in the tested spider mites sampled in Tršice hop-growing region and by 5.3% in Rakovník district, where the lowest mortality for 0.00468% conc. was found (84.0%).

DISCUSSION

As bifentazate has not been used so far to protect hops against resistant strains of two-spotted

spider mites in European hop-yards, this limits the danger of cross-resistance development in *T. urticae* field populations to this acaricide. The highest concentration tested here (0.15%) is the rate submitted for registration. As no spider mites survived that concentration or the subsequent three serial dilutions, it can be assumed that the planned registration rate should ensure the longevity of bifentazate against *T. urticae* on hops in the field. The recommended 0.15% concentration was shown to control *T. urticae* populations in Florida strawberry crops (PRICE & NAGLE 2009). Good results were also obtained in Japan, where OCHIAI *et al.* (2007) found that bifentazate and its principal active metabolite, diazene, showed high toxicity to all life stages of *T. urticae* and *Panonychus citri*.

In consideration of the low concentrations of bifentazate needed to achieve 100% mortality of *T. urticae* compared with the proposed registered concentration we can conclude that this will be a useful acaricide to replace propargite within the anti-resistant strategy of *T. urticae* control not only in Czech but also in other European hop-growing regions. It also had very good efficiency in the control of a field-collected strain of *T. urticae* multiple and cross-resistant to a range of acaricides in Belgium (LEEUEWEN *et al.* 2005), where it showed no sign of cross-resistance. This is a very important discovery for its future utilisation in control strategies against *T. urticae* in European hop-yards. Nevertheless, to ensure its continued high efficacy and low LC_{90} values, good application practice is needed. It consists in maintaining the recommended rate of application together with a rotation of efficient acaricides. Moreover, its great potential as a selective pesticide makes bifentazate a very good prospect for an IPM hop protection system (JAMES 2002).

References

- HŮRKOVÁ J., GESNER M. (1981): Insecticide resistance in Czechoslovak populations of the two-spotted spider mite, *Tetranychus urticae*. IOBC, WPRS Bulletin 1981/IV/3 (Integrated pest and disease control in hops, Liblice, Czechoslovakia, 26. –28. 8. 1980): 61–68.
- JAMES G.J. (2002): Selectivity of the acaricide, bifentazate, and aphicide, pymetrozine, to spider mite predators in Washington hops. International Journal of Acarology, **28**: 175–179.

- LEEUWEN T. VAN, POTTTELBERGE S. VAN, TIRRY L. (2005): Comparative acaricide susceptibility and detoxifying enzyme activities in field-collected resistant and susceptible strains of *Tetranychus urticae*. *Pest Management Science*, **61**: 499–507.
- MALAIS M., RAVENSBERG W.J. (1992): Knowing and recognizing. In: *The Biology of Glasshouse Pests and their Natural Enemies*. Koppert B.V., Berkel en Rodenrijs: 12–18.
- OCHIAI N., MIZUNO M., MIMORI N., MIYAKE T., DEKEYSER M., CANLAS L.J., TAKEDA M. (2007): Toxicity of bifentazate and its principal active metabolite, diazene, to *Tetranychus urticae* and *Panonychus citri* and their relative toxicity to the predaceous mites, *Phytoseiulus persimilis* and *Neoseiulus californicus*. *Experimental and Applied Acarology*, **43**: 181–197.
- PRICE J.F., NAGLE C.A. (2009): Response of two-spotted spider mite populations to programs of abamectin, bifentazate, hexythiazox, spiromesifen, and essential oil of *Chenopodium ambrosioides* miticides in Florida strawberry crops. In: VI International Strawberry Symposium, Huelva, Spain. *ISHS Acta Horticulturae*, **842**: 331–334.
- VOSTŘEL J. (1993): Testování účinnosti pesticidů na svilušku chmelovou (*Tetranychus urticae* Koch). *Ochrana rostlin*, **29**: 13–138.
- VOSTŘEL J. (1996): The results of laboratory experiments and their possible utilization in hop protection strategy against pests. *Rostlinná výroba*, **42**: 320–331.
- VOSTŘEL J. (1999): Hop protection against pests and diseases in Czech Republic (up-to-date information). In: *Proceedings Scientific Commission of I.H.G.C., XVth International Hop Congress*, Pulawy, Poland: 120–122.
- VOSTŘEL J. (2009): Propargite resistance in two-spotted spider mite (*Tetranychus urticae* Koch) on Czech hops. In: *Proceedings II International Humulus Symposium*, Gent, Belgium. *ISHS Acta Horticulturae*, **848**: 165–167.
- VOSTŘEL J., FILKUKA I. (2008): Hop protection against pests and diseases in Central Europe in 2020. In: *Proceedings of the Scientific Commission of the International Hop Growers' Convention*, Scientific Commission, I.H.G.C., Hop Research Center Hüll, Wolnzach, Germany: 63–67.

Received for publication December 23, 2009

Accepted after corrections July 2, 2010

Corresponding author:

Ing. JOSEF VOSTŘEL, CSc., Chmelařský institut, s.r.o., Žatec, Kadaňská 2525, 438 46 Žatec, Česká republika
tel.: + 420 415 732 122, e-mail: j.vostrel@telecom.cz
