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CONTROL OF ROSE SCALE *AULACASPIS ROSAE* (BOUCHÉ) (HEMIPTERA: DIASPIDIDAE) IN GREENHOUSE GROWN ROSES BY RELEASING *RHIZOBIUS LOPHANTAE* (BLAISDELL) (COLEOPTERA: COCCINELLIDAE)

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SUMMARY

Problems with scale insects occur more frequently with the limited use of broad spectrum pesticides of the recent years. In Dutch greenhouses, scales are traditionally a problem in cymbidium, but since three years growers report increasingly the presence of *Aulacaspis rosae* (Bouché, 1933) in rose crops. Chemical control of scale insects is extremely difficult, because the pest spends most of its life hidden under its impenetrable shield. A short overview is given on the scale and on Integrated Pest Management methods: chemical control, spontaneously occurring parasitoids, first trials and releases of beneficials at growers. Biological control of the rose scale using the predatory beetle *Rhizobius lophantae* is now considered a promising alternative to chemical control.

Key-words: scales, rose, greenhouse, Integrated Pest Management, natural enemies.

RÉSUMÉ

Depuis que les pesticides à large spectre d'action sont moins utilisés, les problèmes de cochenilles diaspines augmentent de façon préoccupante en cultures ornementales sous serre. Aux Pays-Bas, celles-ci sont des ravageurs courants en culture de Cymbidium, mais depuis trois ans la présence d'*Aulacaspis rosae* (Bouché, 1933) est de plus en plus rapportée en culture de fleurs coupées de roses. Le bouclier qui caractérise les cochenilles diaspines rend la protection chimique extrêmement difficile. Notre étude offre une synthèse rapide sur *A. rosae* et sur les méthodes de Protection Intégrée : protection chimique, ennemis naturels d'occurrence spontanée, premiers essais de protection intégrée et lâchés d'auxiliaires chez les producteurs. On considère actuellement les introductions de la coccinelle *Rhizobius lophantae* comme une alternative prometteuse à la protection chimique contre la cochenille de la rose.

Mots-clés: cochenilles diaspines, rose, serre, Protection Intégrée, auxiliaires.

INTRODUCTION

Dutch rose growers in greenhouses ared faced with a new insect pest. A grower reported in 2009 the presence of rose scale *Aulacaspis rosae* (Bouché) in his crop. The pest spread on the whole crop despite several pulverisations of all hot spots with broad spectrum insecticides and repeated drench applications of imidacloprid. In order to control the pest the grower had to stop the releases of beneficials and spray repeatedly the whole crop with non-selective pesticides. Since then, growers are seeking to find solutions against this pest to limit its spread. 80% of the IPM rose growers have reported to have found the scale nowadays.

At the request of the Dutch growers and with funding from the Dutch Product Board for Horticulture, Wageningen UR Greenhouse Horticulture conducts since 2010 experiments to improve the integrated pest control strategies against the rose scale.

The rose scale

The genus *Aulacaspis* belongs to the family Diaspididae. In the ancient world, this genus includes 29 species (Ben-Dov *et al.*, 2010), of which only three are described in Europe: *A. rosae* (Bouche, 1833), *A. tubercularis* Newstead 1906 and *A. yasumatsui* Takagi 1977. *Aulacapsis rosae* is originally from Asia, and has been introduced to Europe, America, Australia and Africa (Ben-Dov *et al*., 2010).

Aulacaspis rosae is known under the synonyms: *Anamaspis rosae* Kozarzhevskaya & Vlainic, 1981; *Aulacaspis rosae* Newstead, 1901; *Diaspis rosae* Froggatt, 1914; *D. rosae* Targioni Tozzetti, 1868; *Aulacaspis rosae* Cockerell, 1896; *Aspidiotus rosae* Bouché, 1833; *Chermes rosae* Boisduval, 1868.

The rose scale is mainly found in the woody parts of rose plants. Besides roses, *A. rosae* is found on the following host plants: raspberries, logan berries, *Rubus*, black currant, *Listroderes oblique*, *Agrimonia*, *Cycas*, *Dianthus,* hydrangea, *Laurus, Muehlenbeckia* and *Pyrus* (http://nlbif.eti.uva.nl). Furthermore, its presence has been also reported on Anacardiaceae, Myricaceae and Saxifragaceae (Ben-Dov *et al*., 2010).

The females of the rose scale are protected by a 1.5 to 2.5 mm shield. The shield is dirty white, flat and nearly round. The body of the female under the shield is long, orange to reddish brown in color and 1 mm long. The shield of the young males is oblong, white, flat, with a ribbed texture. Only the adult male is winged. His body is orange-red in color with a spine at the abdomen. Scale insects don’t secrete honeydew.

The female lays between 50 and 150 eggs (Bazarov & Smelev, 1971) in a batch under the shield. The female dies shortly after oviposition. Hundreds of pale red to orange colored crawlers are leaving the shield. They settle on a suitable place and can not subsequently move anymore.

The species has one (Sparrow, 1972) to four (Kosztarab & Kozar, 1988; Kozar, 1990) generations per year. The rose scale overwinters as eggs according to an American publication (Davidson & Peairs, 1966) or in all stages according to European authors (Bénassy, 1961, 1956; Kosztarab & Kozar, 1978).

The crawlers are the only stage that contributes to active dispersal, but only on very small distance. The mortality is high in this phase. Passive dispersal occurs by transport on plants, humans, animals, and air movements.

The rose scale causes direct damage by sucking sap from leaves, twigs and fruits, resulting in growth inhibition, discoloration of leaves and fruits, death of twigs and loss of production. At high density, the stalks and wood are covered with a white coating. Heavy infection can lead to the death of the whole plant (Kosztarab & Kozar, 1988).

Young nymphs are easy to control, but the adult females are difficult to reach with insecticides; even more so if they are piled on each other. Broad-spectrum chemicals are especially effective. Pesticides have to be frequently sprayed with a lot of water with 7 - to 14-day intervals. The addition of a wetting agent is recommended in order to optimize the coverage. Systemic compounds such as imidacloprid can affect older nymphal stages and adult females via the plant juices. Chemical insecticides effective against scale insects are

acetamiprid, deltamethrin, dimethoate, imidacloprid, methiocarb, pyriproxyfen, spirodiclofen, spiromesifen, thiacloprid, and thiamethoxam. Some products of natural origin are also reported to be used against the pest: azadirachtin, pyrethrin and piperonyl butoxide, soaps, oils, algae extracts and products with physical mode of action.
In roses, the scale insects are primarily found on the old wood, in the heart of the plant or lower parts of the plants (bent shoots). But by high infestation levels crawlers reach the flower buds. The effects of plant protection products, even if they work systemically, is often disappointing due to the limited coverage. Growers need to spray carefully for an optimal coverage to get between the bent shoots.
To avoid the establishment of the crawlers some authors recommend the application of mineral oil. Some Dutch growers cover the foot of the plant with a coating balsam after they have treated them with an insecticide.
Beetles are the most studied predators of scales, and more than 20 species of parasitoids have been identified in association with the rose scale. Two of them: *Arrhenophagus chionaspidis* Aurivillius (Hymenoptera, Encyrtidae) and *Adelencyrtus aulacaspidis* (Brèthes) (Hymenoptera, Encyrtidae) occur spontaneously in some Dutch greenhouses. Our research is focussing on testing beneficials and the combination of beneficials and selective chemicals.

MATERIAL AND METHODS

To test the efficacy of four beneficials against the rose scale an experiment was set up in a randomized complete block design with five treatments and three replications in a greenhouse at the research station. The trial was conducted from February to May 2011.
Fifteen experimental cages of dimensions of 1 x 1.5 x 1 m with a metal frame were used. They were covered with fine mesh screen with a 0.22 x 0.31 mm opening size. Each cage contained three rose plants cv. Wham provided by Schreurs (Aalsmeer, NL) and had two zippers through which plants could be handled or examined.
The cages were distributed on eight tables in a greenhouse of 144 m² with 70% RH and a temperature fluctuating around 22°C.
A. rosae colonies were collected at a grower from Stompwijk (NL). The plants were infested with scales on February4th.
Inundative introductions of *Amblyseius swirskii* Athias-Henriot (Acari, Phytoseiidae), *Eretmocerus eremicus* Rose & Zolnerowich (Hymenoptera, Aphelinidae) and *Phytoseiulus persimilis* Athias-Henriot (Acari, Phytoseiidae), were regularly carried out to prevent any establishment of thrips, whiteflies or spider mites.
Treatments were blocked according to a precount of the scale populations on the plants in week 14 on April 6th (Block 1: average 210 scales/cage, Block 2: 1300, Block 3: 12300). The presence of *A. chionaspidis* was detected prior to the release of the natural enemies. The first beneficials were released on the same day. The natural enemies used in this study were supplied by Entocare CV., except the parasitoid *A. chionaspidis* which was reared at Wageningen UR Greenhouse horticulture. The introduction rates were chosen in collaboration with the supplier of beneficials (Table I).

Table I: Introduction of beneficials
(Introduction d' auxilliaires)

Predator	**Supplier**	**Number of introductions**	**Quantity**
Untreated	-	-	-
Karnyothrips melaleucus	Entocare CV., Wageningen, NL	4	50 adults /cage/week
Arrhenophagus chionaspidis	Wageningen UR Greenhouse Horticulture Bleiswijk, NL	4	30 adults/cage/week
Rhizobius lophantae	Entocare CV., Wageningen, NL	4	15 adults/cage/2 weeks

Encarsia citrina	Entocare Cv., Wageningen, NL	4	30 adults /cage/week

Assessments
The counts of scales per cage were recorded on the day of the first introduction and four, seven and ten weeks after the first introduction of biological agents. The number of predators per cage was assessed with a magnifier four, seven and ten weeks after the first introduction of biological agents. Parasitism rate was studied at three data on 100 nymphs of the second stage.

In order to evaluate the presence of *Encarsia citrina* Craw (Hymenoptera, Aphelinidae), 100 pupae from each cage were transferred at three data in ventilated plastic containers (8.5 cm in diameter and 6 cm high, with a ventilation hole of 3 cm in diameter made in the lid and covered with thrips-proof nylon gauze). A 4 x 4 cm section of a yellow sticky trap (Horiver, Koppert, NL) was placed in the container to trap emergent adults. The containers were kept at 20ºC, 80% r.h., and L16:D8 photoperiod during one week. One yellow sticky trap was hung during one week in the cages at the end of the experiment.

Data analysis
An ANOVA using the Generalized Linear Model procedure with binomial distribution was performed for the test on parasitism. A generalized linear model with a Poisson distribution was used for the analyses and the number of scales in the pre-counting was taken into account. For pairwise comparisons of treatment means a likelihood ratio test was used.

RESULTS AND DISCUSSION
During the experiment, the reproduction of the beetle was poor: only one or two larvae of *R. lophantae* were found per assessment in the three cages. *Karnyothrips melaleucus* (Bagnall) (Thysanoptera, Phlaeothripidae) didn't establish at all. *E. citrina* was found sporadically at the end of the experiment (0.7, 2 and 4% of the emerged parasitoids respectively in week 18, 22, 24). Only *A. chionaspidis* was present in all the cages except in cages were *R. lophantae* was released. The beetle predated on all parasitized scales.

On May 3rd, the beetle had already predated 70 % of the scales (Figure 1). In all other treatments, the amount of scales increased despite the introductions of beneficials and the natural presence of *A. chionaspidis*. The pest continued to spawn until the end of the experiment, except in the cages with *R. lophantae* where they were almost eradicated.

Parasitism rates varied between 17 and 49 % (Figure 2). A. *chionaspidis* was the predominant species. No significant difference was observed between the treatments. The release of parasitoids had no additional value.

Figure 1: Scale density per treatment (Km: *Karnyothrips melaleucus*, Ar: *Arrhenophagus chionaspidis*, Rl: *Rhizobius lophantae* and Ec: *Encarsia citrina*)

[Densité de cochenilles par modalité (Km: *Karnyothrips melaleucus*, Ar: *Arrhenophagus chionaspidis*, Rl: *Rhizobius lophantae* et Ec: *Encarsia citrina*)]

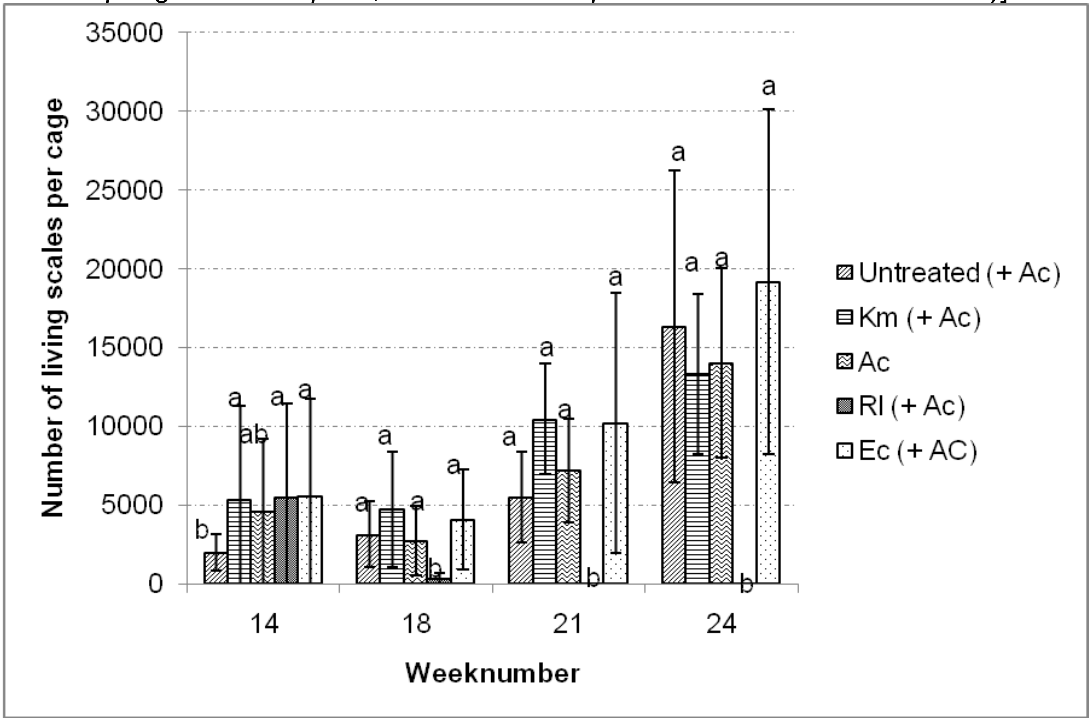
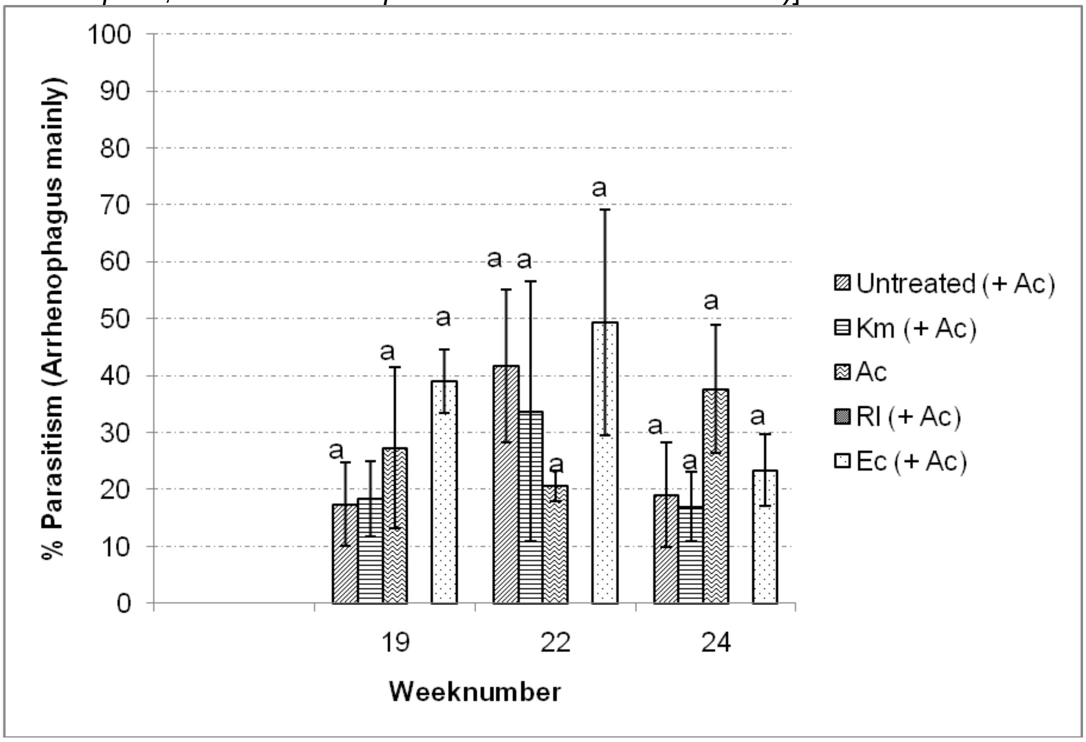


Figure 2: Parasitism rates (Km: *Karnyothrips melaleucus*, Ar: *Arrhenophagus chionaspidis*, Rl: *Rhizobius lophantae* and Ec: *Encarsia citrina*)

[Taux de parasitisme (Km: *Karnyothrips melaleucus*, Ar: *Arrhenophagus chionaspidis*, Rl: *Rhizobius lophantae* et Ec: *Encarsia citrina*)]



Implementation in commercial greenhouses

These results are confirmed with field experience of growers. The scale spreads in the whole crop even with high parasitism rates (60-80%) of *A. chionaspidis.* About 100 *R. lophantae* were introduced by a grower in May 2010 on few hot spots. The beetle was able to maintain itself in the crop during the whole year with rates of 1/20 infested plants during the winter and densities increased to 3 to 9/infested plant from March on. The rose scale dispersed widely in the crop in November, but in April the grower couldn't find any new hot spots. The pest was under control in June. The monitoring of the pest and its natural enemies continues.

Another grower introduces the beetle at a rate of 20 beetles per new hotspot of about 50 scales and is keeping the pest under control until now. The results so far with this predator look very promising.

OUTLOOKS

Most of Dutch growers chose in 2010 to frequently spray the hot spots with neonicotinoids, but they often ended the year with applications of pesticides in their whole crop.

Growers will have to improve their scouting methods to detect the hot spots in an early stage or to apply IPM methods to control the rose scale. More growers are now introducing *R. lophantae* in combination with applications of selective chemicals to restrain the proliferation of the pest.

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