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Research Article

Laboratory and field evaluation of insecticides for the control of *Aeolesthes sarta* Solsky (Col.: Cerambycidae)

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Abstract: Laboratory and field experiments were conducted to determine the efficacy of some insecticides on the control of Sarta longhorned beetle, *Aeolesthes sarta* Solsky adults and larvae. In the laboratory, three pairs of mated and non-oviposited adults were released on the logs of field elm, *Ulmus minor* Mill that had been treated with chlorpyrifos, carbaryl, permethrin or imidacloprid. In the field experiments, artificially infested *U. minor* var. *umbraculifera* Rehd trees were treated by imidacloprid and oxydemeton-methyl through soil and trunk injection. In the laboratory test the best results were obtained from imidacloprid and permethrin applications, because of occurrence of high adult mortality after short period and also preventing egg laying. Despite a few eggs that were laid on the chlorpyrifos treated logs, there were no living larvae in the sprayed logs. Results of the field tests showed that the number of living larvae did not differ significantly between oxydemeton-methyl and control treatment, however, imidacloprid injection was effective in controlling this pest.

Keywords: bark spray, Cerambycidae, Sarta longhorned beetle, injection, urban pests

Introduction

The Sarta longhorned beetle (SLB), *Aeolesthes sarta* Solsky (Coleoptera: Cerambycidae), is an economically important pest of fruit and shade trees (Mazaheri *et al*., 2011). This pest often has a two-year life cycle (Ahmad *et al*., 1977; Orlinskii *et al*., 1991; Mazaheri, 2006). *Aeolesthessarta* adults are generally active from April to late May and often feed partially on the bark of their host trees. Shortly (1-5 days) after adult emergence, females lay eggs in wounds and cracks in the bark of trunks and main branches, for approximately two months (Ahmad *et al*., 1977; EPPO, 2006; Mazaheri, 2006). After egg hatching (9-11 days), the young larvae initially feed under the bark and later in the xylem. Larvae overwinter at the bottom of their feeding tunnels and then continue to feed in spring, and eventually form a pupal chamber in late summer. Newly developed adult beetles spend the winter in this chamber and leave it in the next spring (Mazaheri *et al*., 2011).

Larval tunneling of longhorned beetles results in structural weakness and disrupts the flow of water and nutrients in host trees subsequently causing branch dieback and eventual tree mortality if population densities are high or infestations persist for several years (Morewood *et al*., 2004; Poland *et al*., 2006b; Khan *et al*., 2013). SLB is polyphagous and attacks both stressed and healthy tree species including *Elaeagnus angustifolia, Populus alba, P. nigra, Salix* spp., *Ulmus* spp., *Platanus orientalis, Amygdalus* spp., *Morus alba, Alnussub cordata*, and *Juglans regia* in Iran (Farashiani *et al*., 2000).

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The current control methods recommended for managing the pest include phytosanitary measures, planting less sensitive species and varieties, identification and destruction of infested trees, and treatments with chemical and biological insecticides (EPPO, 2006). Some studies have been concentrated on the biological and microbiological control of this pest, but little success was obtained (EPPO, 2006, and Farashiani *et al*., 2000).Systemic insecticides are suitable candidates for control programs against wood borer larvae feeding on the cambium and sapwood (Poland *et al*., 2006a). Trunk injection is preferred in the control because of low drift, systemic distribution, minimum mammalian and beneficial organism toxicity, and high efficacy (Mccullough *et al.,* 2004; Poland *et al*., 2006a; Doccola *et al.,* 2007; Haack *et al*., 2010).

Imidacloprid is a systemic and translaminar neonicotinoid insecticide with stomach and contact activity against a variety of pests in the orders Hemiptera, Coleoptera, Diptera, and Hymenoptera (Elbert *et al*., 1991; Poland 2006a; Yu, 2008). Imidacloprid is an injectable insecticide that has been considered to be effective in controlling a variety of borers, sucking insects, cone and seed pests (Byrne *et al*., 2014; Grosman *et al.,* 2002; Harrell, 2006; McCullough *et al*., 2004; Mota-Sanchez *et al*. 2009; Poland *et al*., 2006a; Young, 2002). Permethrin is a broad-spectrum pyrethroid insecticide inducing repetitive discharges in sensory neurons by acting as sodium channel modulator (Yu, 2008) (Table 1). The best features of this insecticide include low phytotoxic effect on many plants, rapid degradation in soil, and minimum non-target organism toxicity (Kamrin, 1997). Chlorpyrifos and Oxydemeton-methyl are organophosphate insecticides and act as acetylcholinesterase inhibitors. Chlorpyrifos is a broad-spectrum and one of the most widespread organophosphate insecticides according to the United States Environmental Protection Agency (EPA). This insecticide has contact and stomach effects against various pests (Kamrin, 1997). Oxydemeton-methyl is a systemic insecticide with prolonged protective effect and high initial toxicity especially against mites, thrips and aphids. Oxydemeton-methyl can immediately penetrate into the plants after application (Gruzdyev *et al*., 1983). Carbaryl is a wide-spectrum stomach and contact insecticide in the carbamate family inhibiting acetylcholinesterase action (Gruzdyev *et al*., 1983). Carbaryl is one of the most used carbamate insecticides (Yu, 2008) (Table 1). These three insecticides were selected because of their wide applications, low mammalian, beneficial organisms and plant toxicity, and being systemic and trunk-injectable (imidacloprid and oxydemeton-methyl).

The objectives of this study were: 1) to evaluate the toxicity of four insecticides, imidacloprid, permethrin, chlorpyrifos and carbaryl on SLB adults through bark spray in laboratory, and 2) to compare the efficacy of two systemic insecticides, imidacloprid and oxydemeton-methyl, to control SLB larvae through soil and trunk injection in artificially infected trees.

Table 1 Insecticide products, chemical group, mode of action, application rate and method for elm trees treated against *Aeolesthes sarta*.

Technical name	Chemical group	MoA[1,2]	Bark spray rate (mg/l)	Application method
Imidacloprid (Confidor®) Bayer EC 35%	Neonicotinoid	nAchR agonist	1000	Spraying, Trunk/Soil injection
Permethrin Melli Agrochemical Co. (MAC) EC 25%	Pyrethroid	Sodium channel modulator	1000	Spraying
Chlorpyrifos MAC EC 40.8%	Organophosphate	AChE inhibitor	2500	Spraying
Carbaryl MAC WP 85%	Carbamate	AChE inhibitor	3000	Spraying
Oxydemeton-methyl MAC EC 25%	Organophosphate	AChE inhibitor	-	Trunk/Soil injection

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[1] MoA: Mode of action, nAchR = nicotinic acetylcholine receptor, AChE = acetylcholinesterase.

[2] Mode of action based on IRAC (2015).

Materials and Methods

Collection of Sarta longhorned beetle (SLB)

Newly emerged SLB adults were collected from caged trunk and branch sections (short logs) of elm trees (≈ 1 m long and 12-25 cm in diameter) at Isfahan (32°38′N 51°39′E) landscape in March 2005. Top of the short logs were sealed with melted paraffin and the unsealed end placed down into the moist sand. To collect enough SLB adults, approximately 70-80 short logs were placed in four large cages (2 × 2 × 2 m). Cages were held under natural conditions at maximum 28 ± 3 ºC, minimum 9 ± 2 ºC, 25 ± 2% relative humidity (RH), and 14:10h L:D photoperiod. Newly emerged beetles were collected daily and kept separately at room temperature in a 2 L glass jar and provided with a young elm twig. Beetles were stored according to collection date and sex.

Effect of bark spray on adult survival

The efficacy of our insecticides, imidacloprid (Confidor®, Bayer, Germany, EC 35%), chlorpyrifos (Melli Agrochemical Company (MAC), Qazvin, Iran, EC 40.8%), carbaryl (MAC, WP 85%), and permethrin (MAC, EC 25%), at concentrations near to their recommended rates (Table 1) and water (as a control treatment) against SLB adults was evaluated under laboratory conditions (27 ± 2 ºC, 34 ± 2% RH, and 14:10h L:D photoperiod). The experiments were laid out in a completely randomized design. Cut logs (13 cm in diameter, 50 cm in length) of elm tree, *Ulmus minor* MillBorkh. (a preferred host for this beetle) were treated with insecticide solutions or water. In order to provide a full coverage of the insecticides, treatments were applied with a hand sprayer with three bar pressure (Gloria-Werke, Wadersloh, Germany). The logs were sprayed until run-off, with about 250 ml of spray solution per log, and allowed to dry for an hour. The distal end of each log was sealed and their bases were placed in the moist sterile sand to slow down desiccation. Each treated log was assigned randomly to one experimental cage measuring 90 cm long × 40 cm wide × 70 cm high. Each treatment was replicated four times and one cage served as one replication. A pair of SLB adults (one male and one female) were placed in cylinder dishes (25 cm long × 17 cm diameter) and allowed to mate 48 h before exposure to the treatments. Three mated and non-oviposited pairs, randomly selected from different collection dates, were released in the center of each cage. Adult mortality was scored one day after treatment and then every two to three days until death of all adults (about 30 days after release). On each date, the logs were also examined to determine the number of eggs laid. All dead females were dissected to determine the number of eggs remaining in their abdomen. The logs were held for two months at the mentioned condition to allow larval establishment, and then dissected to record the number of live larvae and their weight.

Effect of insecticide injection on larval survival

The experiment was carried out in an elm (*Ulmus minor* var. *umbraculifera* Rehd.) plantation, at northwest Isfahan on Isfahan University of Technology campus, consisting of approximately 400 thirty-year-old trees, spaced two to three meters apart. Elm trees were not infested with SLB, due to the isolation of the area and proper management practices i.e. adequate irrigation and fertilization scheduling. Trees had 10-20 cm diameter at breast height (DBH, ie at 1.4 m stem height) and had a height of 4-5 meters. A net cage was fastened around the main stem of each of the 32 trees located in the interior part of the plantation. The cages covered tree trunks from 30 cm to 1.5 m above ground. By late April, the date coinciding with the peak emergence of overwintered adult in the natural conditions (Mazaheri, 2006), the collected beetles were partitioned evenly among the cages. Each tree (cage) received three pairs of SLB, by releasing the beetles at the bottom of each cage. The experimental plot was subjected to eight treatments with four replications in a randomized complete block design. The treatments were: a) imidacloprid, b) oxydemeton-methyl (MAC, EC 25%), and c) water as control treatment using two methods of soil and trunk injections at two or three application times. Details of the application rates, methods and dates are presented in Table 2. Trees were grouped into four blocks, according to DBH. Two application dates were used for each treatment based on the pest seasonal population fluctuations (Mazaheri, 2006): seven and four weeks before peak of first instar larvae (mid-May) in the soil injection treatments, five and two weeks before peak of first instar larvae (mid-May) in the trunk injection treatments. For the trunk injection with three application times, one more injection was applied coinciding with the peak of first larval instar (mid-May) (Table 2). Selected doses of insecticides (Table 2) were diluted in 10 L of water per 2.5 cm of tree DBH. The materials were applied with a power soil injector capable of a range of 70 to 100 PSI at the pump with a standard soil-injector needle. Seven soil holes 25 cm deep and one cm in diameter were made in soil in a circle of 140 cm diameter around the trunk and spaced approximately 60 cm apart. Trees were irrigated four hours before injection. In the trunk injection, a hole approximately of 0.6 cm in diameter, 2.5 cm in depth (in sap wood) on a 45 degree angle to the main trunk was drilled 15 cm above the soil-surface. Injection pressure was 240 PSI at the pump and 20 ml was injected in each stroke. All injections were performed using a hydraulic pump. Four months after injection (early September), injected trees were cut down and dissected to determine the number of live SLB larvae.

Statistical analyses

In the bark spraying experiment, the percentages of adult mortality were corrected for control mortality using Abbott's formula, (Abbott, 1925) then they were arcsine transformed before analysis. The effects of insecticides on adults and larvae were compared among treatments by single-factor analysis of variance (ANOVA). Means were compared with Duncan's multiple range test at the 5% level.

In insecticide injection tests, number of living larvae was analyzed by two-factor ANOVA, the two factors being insecticide type and injection method. All data were analyzed using the SAS software (SAS Institute, 1999).

Table 2 Treatments information of insecticide injection experiments against *Aeolesthes sarta* in Isfahan landscape in 2005.

Treatment	Imidacloprid		Oxydemeton-methyl		Control (water)	
	Trunk	Trunk	Soil	Trunk	Trunk	Soil
No. of applications	2	3	2	2	3	2
Application dates	Apr 14 May 5	Apr 14 May 5 May20	Mar30 Apr 19	Apr. 14 May 5	Apr 14 May 5 May 20	Mar 30 Apr 19
Rate (g AI/DBH)[1]	0.5	0.5	1.75	3	3	8.75
Mean number of live larvae 4 months after injection[2]	0 b	0 b	0 b	6.3 ± 1.03a	6.6 ± 0.9a	5.9 ± 1.4a

[1] Gram active ingredient (AI) / 2.5 cm diameter at breast height (DBH).

[2] Means followed by the same letters in a row are not significantly different (Duncan's Multiple Range test, $P < 0.05$).

Results

Effect of bark spray on adult survival

Logs treated with the tested insecticides were toxic to SLB adults. Different treatments caused significant differences in terms of efficacy on SLB adult mortality. Results showed that cumulative mortality (%) was increased by time (Table 3). Adults mortality reached 100 percent 6, 9, 13 and 17 days after treatment (DAT) for logs treated with imidacloprid, permethrin, chlorpyrifos and carbaryl, respectively (Table 3), whereas natural mortality of adults on control logs reached 100% on the 30th day (adult longevity is about one month) and mortality in control after 17 days was less than 15 percent.

The number of eggs laid on control logs (87.1 ± 5.7) were significantly more than those laid on carbaryl and chlorpyrifos-treated logs (F = 399.6; df = 4, 15; P < 0.0001) (Table 4). No living larvae were found on logs treated with imidacloprid and permethrin (Table 4). The number of eggs remaining in the female's abdomen was negatively correlated with the number of eggs laid on logs. Females released on imidacloprid and permethrin-treated logs, had significantly more eggs in their abdomen after death (98.5 ± 20.6 and 97.1 ± 19.8, respectively) than those in other treatments (F = 12.9; df = 4, 15; P < 0.0006) (Table 4). Because females on insecticide-treated logs had a shorter life span than those on control logs, it was expected that less oviposition would occur on the treated logs.

The number of living larvae was significantly higher in control logs (10.5 ± 0.7) than that in carbaryl-treated logs (5.9 ± 0.9) (F = 180.7; df = 4, 15; P < 0.0001), whereas it was the least in chlorpyrifos-treated logs (zero) (Table 4).

There was no significant difference in larval weight and head capsule width among carbaryl-treated logs and control logs (Table 4).

Effect of insecticide injection on larval survival

Imidacloprid injection of soil (two times application) and trunk (two and three times application) r resulted in significantly higher control (100%) of SLB larvae (F = 54.9, df = 7, 21; P < 0.0001) (Table 2). Imidacloprid-injected trees had neither live nor dead larvae and only a few eggs were seen on the treated trees.

Oxydemeton-methyl-injected trees and control trees were not significantly different in terms of mean number of living larvae (Table 2). One month after the first injection, oxydemeton-methyl-treated trees through soil or trunk injections showed excessive phytotoxicity. In these trees with dried leaves, high survival of larvae was observed.

Table 3 Cumulative mortality of *Aeolesthes sarta* adults released on elm logs sprayed with four insecticides under laboratory conditions.

Insecticide	Corrected cumulative adult mortality (%)[1] Days after spray						
	1	2	4	6	9	13	17
Imidacloprid	0	33.3 ± 0a	82.6 ± 0a	100a			
Permethrin	0	33.3 ± 0a	74.4 ± 5a	81.8 ± 0bc	100a		
Chlorpyrifos	0	28.9 ± 4.2ab	78.6 ± 4.3a	89.5 ± 4.5b	98.7 ± 5a	100a	
Carbaryl	0	20.4 ± 4.2b	56.5 ± 8.7b	69 ± 8.7c	84.6 ± 8.2b	93.3 ± 7.2b	100
CV	0	33.3 ± 0a	82.6 ± 0a	100a			

[1] Means followed by the same letters in each column are not significantly different (Duncan's Multiple Range test, P < 0.05).

Table 4 Some biological parameters of *Aeolesthes sarta* released on elm logs one hour after spray with different insecticides under laboratory conditions.

Treatment	Mean ± SE (%)[1]				
	No. of eggs per log[2]	No. of living larvae per log[3]	Weight of living larvae (g)[3]	Larval head capsule width (mm)[3]	No. of eggs per female's abdomen
Imidacloprid	0 c	0 c	0 b	0 b	98.5 ± 20.6 a
Permethrin	0 c	0 c	0 b	0 b	97.1 ± 19.8 a
Chlorpyrifos	34.8 ± 2.4 b	0 c	0 b	0 b	32.9 ± 4.06 b
Carbaryl	37.4 ± 1.8 b	5.9 ± 0.9 b	0.47 ± 0.05 a	4.8 ± 0.17 a	28.5 ± 6.3 b
Water (control)	87.1 ± 5.7 a	10.5 ± 0.7 a	0.49 ± 0.04 a	4.5 ± 0.17 a	6.4 ± 0.57 c
CV	9.46	19.17	14.41	6.13	22.9

[1] Means followed by the same letters in each column are not significantly different (Duncan's Multiple Range test, $P < 0.05$).
[2] The number of eggs was assessed seventeen days after release.
[3] The larval parameters were assessed two months after release.

Discussion

Effect of bark spray on adult survival

Analysis of data indicated that different treatments caused significant differences in efficacy of SLB adult oviposition and mortality (Table 1). The possible reason could be probably due to differences in mode of action and metabolism of these chemicals (Yu, 2008). No eggs were found on imidacloprid and permethrin-treated logs that may be associated with the repellent or anti-oviposition or rapid knockdown effects of these insecticides on adults. It has been demonstrated that imidacloprid is both a toxin and antifeedant compound (Elbert *et al*., 1991). Poland *et al.* (2006a) reported that imidacloprid had both strong anti-feedent and toxic effects against *Anoplophora glabripennis* Motsch. And *Plectrodera scalator* Fabricius (Coleoptera: Cerambycidae) larvae and adults.

Foliar spraying of imidacloprid on Scots pine trees was found to be effective against *Tomicuspiniperda* L. (Coleoptera: Scolytidae) (Mccullough and Smitley, 1995).Application of two pyrethroid insecticides, cyfluthrin (Tempo®) and bifenthrin (Onyx®) provided consistently high control levels (82 to 97%) of *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae). These insecticides may affect both adults and newly hatched larvae (Mccullough *et al*., 2004). Trunk sprays in spring 2007 and 2008 with dinotefuran or imidacloprid reduced *A. planipennis* larval densities in fall 2008 (McCullough *et al*., 2011). Spraying of deltamethrin and diflubenzuron provided the greatest control of horse chestnut leaf miner than that of other tested insecticides or protectant compounds, especially when repeated twice, with 100% insect control in some cases (Percival *et al*., 2012).

In Goodwin's study (2005b), the emerging adults and larvae of fig longicorn, *Acalolepta vastator* Newman, and infesting grapevines were controlled by single dormant spray of imidacloprid, fipronil or bifenthrin at high rates of application. In another study, chlorpyrifos reduced populations of *A. vastator,* yet showed no residual toxicity after 24 h (Goodwin, 2005a).

The lack of living larvae in chlorpyrifos-treated logs could be associated with the mortality effect of this compound on eggs and newly hatched larvae. Similar results had been reported for other organophosphorus insecticides on the eggs and first instar larvae of *Anoplophora glabripennis* and *Apriona germari* Hope (Coleoptera: Cerambycidae) (Fan *et al*., 1997).

Our results demonstrated the high efficacy of bark spraying with imidacloprid and permethrin in controlling the pest, because of high adult SLB mortality in shorter period and inhibition of oviposition. Chlorpyrifos did not prevent adult oviposition, but the lack of living larvae in the sprayed logs implies that this insecticide is also effective against SLB. Carbaryl seemed to be an ineffective and not a suitable compound.

Effect of insecticide injection on larval survival

The highest control of SLB larvae was observed when imidacloprid was injected into the soil or tree trunk. Probably after egg hatching, SLB larvae were exposed to lethal levels of imidacloprid concentrations when initially fed under the bark in cambium and phloem tissues. Poland *et al.* (2006b) found that imidacloprid injection of infested trees resulted in significant mortality in *A. glabripennis* adults feeding on leaves and twigs and larval stages feeding within infested trees. Distribution of trunk-injected imidacloprid in elm trees has not been investigated. However, it was demonstrated that ^{14}C-imidacloprid translocates mainly in the xylem of *Fraxinus* spp., and the highest concentration was detected in the ash leaves (Mota-Sanchez *et al*., 2009).In imidacoloprid-injected Norway maple trees, the concentration of imidacloprid in twig bark was much higher than that of the twig xylem (Ugine *et al*., 2013). Imidacloprid could cause higher mortality to the *A. glabripennis* beetles than other tested insecticides (disulfoton, oxydemeton-methyl, methamidophose, and acephate), especially when applied through trunk injection (Wang *et al*., 2000). In McCullough *et al*.'s study (2004), high-pressure soil injections of imidacloprid (Merit® 75 WP) provided 88-92% control of *A. planipennis* larvae and trunk injection of Imicide® (Mauget capsules of imidacloprid) reduced *A. planipennis* density by roughly 60 to 96 percent. Microinjected imidacloprid into infested eucalyptus trees provided control of *Glycaspis brimblecombei* Moore (Homoptera: Psyllidae) more effectively than oxydemeton-methyl (Young, 2002). Imidacloprid trunk injection proved to have a high efficacy against avocado thrips, *Scirtothrips perseae* Nakahara, because of its toxic concentrations in leaf tissues (Byrne *et al*., 2014). Acephate injection at 1.00 g/cm DBH resulted in 85-100% *Uraba lugens* Walker (Lepidoptera: Noctuidae) mortality (Rolando *et al*., 2011).

Soil and trunk injections of oxydemeton-methyl showed phytotoxicity on treated trees. It could be probably due to application of high concentration of oxydemeton-methyl. In these weakened trees with low moisture content and slow sap flow, the high survival of larvae was observed.

Bark spraying of imidacloprid and permethrin, demonstrated anti-oviposition and lethal effects on SLB adults and potential for use in *A. sarta* management programs. Application of a systemic insecticide, imidacloprid to the trunk or soil could be considered as a suitable protective measure against SLB larval penetration.

The highest SLB larval mortality rate occurred on elm trees injected with imidacloprid. Injecting trees with systemic insecticides would be one tool in a comprehensive program for managing longhorned beetle populations when the eradication program fails. Mortality of SLB adults feeding on insecticide-treated trees as well as mortality of larval stages within the injected trees would reduce pest populations and damages. Furthermore, it is possible that mortality of a significant percentage of the longhorned beetle population within a tree shall reduce the pest damage to levels that the tree could withstand. Insecticide injection may complement other tools in an eradication program by protecting uninfested trees in areas surrounding removed infested trees. If very low residual population remains in the tree-removal area that is below the detection threshold, individuals would encounter insecticide-treated hosts and significant numbers would die. This could help to reduce the residual population to a level below a minimum viable population size and thus lead to ultimate eradication. To successfully implement systemic insecticides in SLB management, it is critical to deliver a high and sustained dose of insecticide. So, further investigations on the effects of various doses of systemic insecticides are required to determine the minimum effective dosage. Studying of the residual effects of these insecticides/application methods on the adult beetle, during its long period of emergence is also suggested.

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ارزیابی آزمایشگاهی و مزرعه‌ای حشره‌کش‌ها برای کنترل سوسک شاخک بلند سارتا
Aeolesthes sarta Solsky (Col.: Cerambycidae)

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چکیده: به‌منظور درک اثر حشره‌کش‌ها روی مراحل لاروی و بالغ سوسک شاخک بلند سارتا *Aeolesthes sarta* Solsky، مطالعات آزمایشگاهی و مزرعه‌ای انجام گرفت. در شرایط آزمایشگاه، سه جفت حشره بالغ جفت‌گیری کرده که هنوز تخم‌گذاری نکرده‌اند، روی تنه درختان نارون (*Ulmus minor* Miller) تیمار شده با کلرپیریفوس، کارباریل، پرمترین و ایمیداکلوپرید رهاسازی شدند. در شرایط مزرعه‌ای، اثر حشره‌کش‌های ایمیداکلوپرید و اکسی دیمتون متیل از طریق تزریق تنه و خاک به درخت‌های نارون (*U. minor* var. *umbraculifera* Rehd) آلوده شده به‌طور مصنوعی، مورد ارزیابی قرار گرفت. در آزمایشگاه، بهترین نتیجه توسط ایمیداکلوپرید و پرمترین ارزیابی شد که به دلیل مرگ و میر بالای بالغین در زمان کوتاه‌تر و جلوگیری از تخم‌گذاری بالغین بود. اگرچه تعداد تخم اندکی روی تنه‌های تیمار شده با کلرپیریفوس گذاشته شده بود، لارو زنده‌ای در تنه‌های اسپری شده وجود نداشت. نتایج آزمایش‌های مزرعه‌ای نشان داد که تعداد لاروهای زنده بین درخت‌های کنترل و تیمار شده با اکسی دیمتون متیل تفاوت معنی‌داری ندارد، اما تزریق ایمیداکلوپرید در کنترل آفت مؤثر بود.

واژگان کلیدی: سمپاشی تنه درختان، Cerambycidae، سوسک شاخک بلند سارتا، تزریق درختان، آفات شهری