

# POSSIBILITIES OF BIOLOGICAL CONTROL OF SAN JOSE SCALE (*DIASPIDIOTUS PERNICIOSUS*)

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*Abstract:* The San Jose scale (*Diaspidiotus perniciosus*) is a wide spread pest in the Czech Republic. Its harmfulness is increasing over the last years. The trees may die due to suction of the phloem. The only stage that is sensitive to treatments is a crawler that is not protected by cover. Possible control methods are limited to applications of oil based preparations in early spring in organic agriculture. We were testing different preparations suitable for organic agriculture against San Jose scale nymphs during years 2014 and 2015. In 2014 the highest efficacy was achieved with preparation Naturalis up to 85.2% but the most stable efficacy during the whole season was achieved with treatment Spintor (38.9–78.4%). In 2015 the results were not statistically significant due to very extreme temperatures during the periods of applications.

*Key Words:* San Jose scale, *Beauveria bassiana*, *Pongamia pinnata*, spinosad

## INTRODUCTION

The San Jose scale (*Diaspidiotus perniciosus*) is known all over the world and it is widely distributed. This pest is important especially in fruit production and it is often intercepted in quarantine mainly on oranges and tangerines (Miller, Davidson 2005). The European Union deleted it from the list of quarantine pests because of its extension in almost all European states. Significant damages are recorded mainly on apples, pears, peaches, plums, currants and many other plants. On fruit trees this scale develops on vegetative organs, blossoms and fruits and it is often found on trunks and branches (Figure 1). Due to suction of the phloem the trees may die (Crop Protection Compendium 2014). The population of the San Jose scale started to increase at the end of the 90s because the nonselective pesticides were eliminated in the integrated pest management in the Czech Republic (Kocourek, Stará 2011).

The San Jose scale is almost all its life protected by protecting cover, which makes the control of this pest very difficult. Because of the cover, applied pesticides cannot reach any sensitive part of its body, and are therefore not providing effective control. The only stage that is sensitive to treatments is nymph (crawler) that crawls out of female cover (Figure 2, 3) after 33 to 40 days after fertilization. When the crawlers find a suitable place to suck they settle down and start to make their own cover. This can happen even after two hours if the conditions are appropriate. Therefore it is necessary to manage the application of pesticides in time (Miller, Davidson 2005). The emergence of males is observed using pheromone traps.

The aim of this research was to find a suitable biological treatment effective against the San Jose scale.

## MATERIAL AND METHODS

In 2014 and 2015 we tested three products: Spintor (a.i. spinosad, dosage  $0.6 \text{ l} \cdot \text{ha}^{-1}$ ), Naturalis (a.i. spores of *Beauveria bassiana*, dosage  $2 \text{ l} \cdot \text{ha}^{-1}$ , Figure 4) and Wetcit (a.i. orange oil, dosage 0.3%). Control variant without any application was included. The treatments were applied by backpack sprayer. The small-plot trial was carried out in pear variety Williams in Kobyly (South Moravia). Each variant included 20 trees.

The presumed terms of emergence of males and crawlers were set according to Alston et al. (2011) using the effective temperature sums recorded from data from meteorological stations. The exact term of male emergency was set by pheromone traps. Sexual pheromone of San Jose scale female from International Pheromone Systems Ltd was used in all traps. Occurrence of crawlers was determined using double site sticky tape on branches. They were checked every day in expected period of crawler emergence. The first term of application was set as 7 days after the first crawler emerged in each generation. Following applications were done 6–10 days after the previous one according to weather conditions. The evaluations were done just before the next application as following: 10 lengths of shoot, each 20 cm long, were randomly selected on all trees in each plot. Counts of living scales were made under a binocular microscope. The efficacy is set according to Abbott's formula.

In year 2014 we made three applications of treatments against first generation in June 9<sup>th</sup>, June 15<sup>th</sup> and June 21<sup>st</sup>, and three applications against the second generation in August 12<sup>th</sup>, August 19<sup>th</sup> and August 29<sup>th</sup>. Evaluations were done in June 15<sup>th</sup>, June 21<sup>st</sup>, June 25<sup>th</sup>, August 19<sup>th</sup>, August 29<sup>th</sup> and September 4<sup>th</sup> 2014.

In year 2015 we made three applications of treatments against first generation in June 18<sup>th</sup>, June 29<sup>th</sup> and July 6<sup>th</sup>. The evaluations were done in June 29<sup>th</sup>, July 6<sup>th</sup> and July 10<sup>th</sup> 2015.

## RESULTS AND DISCUSSION

The occurrence of San Jose scale was highly variable in different variants in 2014. Branches without any scales and also branches with hundreds scales were recorded. Therefore the statistically significant difference was found only in two terms in the second generation (Table 1). The number of scales in Spintor variant was significantly lower than in control variant in August 19<sup>th</sup>. All variants were significantly different from the control variant ( $F 4.45$ ,  $p 0.005$ ) in September 4<sup>th</sup>. In total Spintor was the most stable of all treatments in this year (56.6% in average), but the ecotoxicological profile is worse compared to Naturalis. The treatment Naturalis reached very high efficacy in some terms (85.2% in June 15<sup>th</sup>), however it had almost no efficacy in other terms of application (2.1% in June 25<sup>th</sup>). The oil treatment Wetcit had high variability of efficacy and satisfactory in few terms, but it had the lowest efficacy in average (31.5%). Shaw et al. (2000) found out that oil treatments have a good efficacy also during the vegetation in New Zealand and can be a good alternative to chemical control of San Jose scale.

Table 1 Average occurrence of San Jose scale covers in 2014. The efficacy is set according to Abbott's formula

Date	Spintor		Naturalis		Wetcit		Control Average occurrence
	Average occurrence	Efficacy %	Average occurrence	Efficacy %	Average occurrence	Efficacy %	
June 15 <sup>th</sup>	4.7 <sup>a</sup>	68.5	2.2 <sup>a</sup>	85.2	6.0 <sup>a</sup>	59.7	14.9 <sup>a</sup>
June 21 <sup>st</sup>	25.3 <sup>a</sup>	38.9	15.4 <sup>a</sup>	62.8	32.2 <sup>a</sup>	21.3	41.4 <sup>a</sup>
June 25 <sup>th</sup>	16.3 <sup>a</sup>	50.6	32.3 <sup>a</sup>	2.1	37.2 <sup>a</sup>	-	33
Aug 19 <sup>th</sup>	5.2 <sup>b</sup>	78.4	13.6 <sup>ab</sup>	43.6	18.4 <sup>a</sup>	23.7	24.1 <sup>a</sup>
Aug 29 <sup>th</sup>	13.3 <sup>a</sup>	43.2	19.4 <sup>a</sup>	17.1	21.3 <sup>a</sup>	9.0	23.4 <sup>a</sup>
Sept 4 <sup>th</sup>	20.9 <sup>b</sup>	60.2	24.9 <sup>b</sup>	52.6	29.5 <sup>b</sup>	43.8	52.5 <sup>a</sup>

The year 2015 was very extreme for San Jose scale. There were no significant differences between used treatments in the first generation. The population of crawlers was too low in the second generation, that it was not possible to realize the experiment. The temperatures were very high in the periods of applications. It affected the efficacy of treatments and emergency of crawlers the most. The developmental thresholds are 10.6–32.2°C (Badenes-Perez et al. 2002).

It is known that spores of *Beauveria bassiana* are damaged caused by direct sunlight. It can be assumed Naturalis has rather short-term efficacy and it is not very suitable for use in periods with high intensity of solar radiation.

## CONCLUSION

In 2014 the highest efficacy was achieved with preparation Naturalis, which has also very good ekotoxicological profil. The most stable efficacy during the whole season was achieved with treatment Spintor.

The right timing of treatment application is the most important, because the crawlers can create their protective cover in several hours if the conditions are suitable. That is why it is necessary to observe this pest and set the right term of applications, when there is the highest density of uncovered crawlers. Also the weather, mainly the solar radiation and temperature can negatively affect the efficacy of treatments.

Figure 1 Infested branch

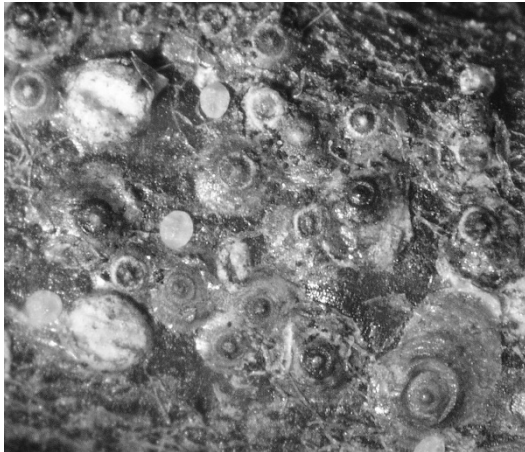


Figure 2 San Jose scale female with nymphs

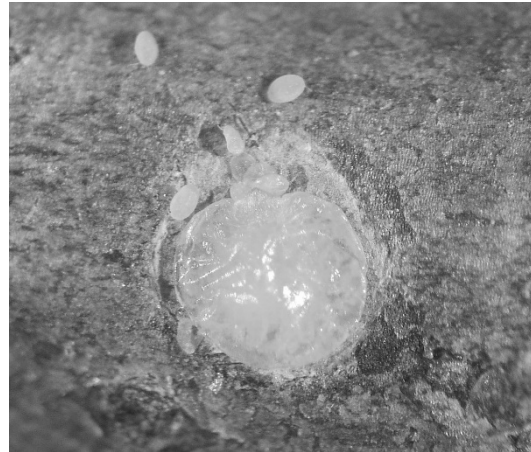


Figure 3 Mobile nymphs called crawlers

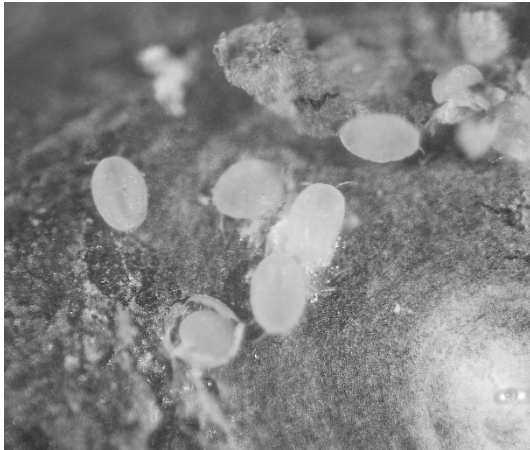


Figure 4 Crawlers attacked by *Beauveria bassiana*



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