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Risk assessment on vegetative parameters in the production of fruit planting material from the San José scale

Оценка на риска върху вегетативни параметри при производството на овощен посадъчен материал от калифорнийска щитоносна въшка

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ABSTRACT

The use of fruit-propagated planting material is vital for the fruit market, but unclear phytosanitary conditions can cause significant losses. Bulgaria and other EU countries comply with high standards for producing fruit trees. Protected tree fruit cultivation is a promising alternative using sustainable practices to improve fruit quality and tree health. New information has been obtained on the development of the San José scale, *Diaspidiotus (Quadraspidiotus) perniciosus* Comstock, in protected facilities. Using infested propagating material causes greater damage to plants compared to the migration of the species. The harmfulness of the pests was high, and there was an extreme risk of infestation when using nets to produce planting material. The San José scale's harmfulness in apple fruit (*Malus domestica* Borkhausen) was found to be significantly higher in the insect-proof net house at 75.0%. In the shaded field, this coefficient was 71.7%, and in the non-shaded field, it was 56.7%. Strict measures to limit the spread of the pest have been effective in reducing its harmfulness, offering a sense of control and optimism in managing this issue.

Keywords: *Quadraspidiotus perniciosus*, harmfulness, fruit plant material, apple, plum, sweet cherry

АБСТРАКТ

Използването на здрав посадъчен материал е жизненоважно за пазара на плодове, но неясните фитосанитарни условия могат да причинят значителни загуби. България и други страни от ЕС спазват високи стандарти за производство на овощни дървета. Отглеждането на посадъчен материал в защитени съоръжения е обещаваща алтернатива, използваща устойчиви практики за подобряване на качеството на плодовете и здравето на дърветата. Получена е нова информация за развитието на калифорнийска щитоносна въшка, *Diaspidiotus (Quadraspidiotus) perniciosus* Comstock в защитени съоръжения. Използването на заразен посадъчен материал причинява по-големи щети на растенията в сравнение с разселването на вида. Вредността на неприятелите е висока, а при използване на мрежи за производство на посадъчен материал има изключителна опасност от нападение. Комплексният коефициент на вредност на калифорнийска щитоносна въшка при ябълка (*Malus domestica* Borkhausen) показа значително по-висок процент, изчислен в депо изолатор – 75.0. В засенчено поле този коефициент е 71.7%, а при поле на открито – 56.7%. Спазването на строги мерки за ограничаване на разпространението на вида може да намали вредоносността на неприятеля.

Ключови думи: *Quadraspidiotus perniciosus*, вредоностност, овощен посадъчен материал, ябълка, слива, череша

INTRODUCTION

The growth and yield of cultivated plants are influenced by the climate and soil conditions of the cultivation site, as well as the plantation management practices. The duration of the different growth stages and the timing and quantity of the harvest are also affected by these factors (Fischer et al., 2016). However, over the past decade, climate change and variability have had a major impact on crops' growth and production, which has significantly affected global food security (Dhankher and Foyer, 2018; Ivanov, 2022).

Protected tree fruit cultivation has become a promising alternative to tackle the various biotic and abiotic stresses threatening fruit production under climate change. This cultivation method uses sustainable and environmentally friendly practices to improve fruit quality and maintain tree health. Nowadays, nets are being used globally to safeguard trees against harsh environmental conditions such as hail, wind, excess sunlight, and pests. In addition to protecting the trees, nets also enhance the quality of fruit produced and the fruit propagation material (Manja and Aoun, 2019; Ivanov and Dimitrov, 2022).

In 2002, a significant milestone was reached by adopting the International Standard for Phytosanitary Measures (ISPM) No. 16 titled' Regulated Non-Quarantine Pests: Concept and Application'. This standard comprehensively described Regulated Non-Quarantine Pests (RNQPs) and their characteristics. Furthermore, in 2016, ISPM No. 2016,' Pest Risk Analysis for Regulated Non-Quarantine Pests,' was adopted internationally, outlining the procedure for conducting a risk analysis for RNQPs (FAO, 1999).

Measures are taken to prevent the introduction and spread of quarantine pests through exclusion, eradication, and containment to avoid negative impacts on the economy, environment, and society. On the other hand, the RNQP concept aims to avoid unacceptable economic impacts on the crops intended to be planted by pests already in the area. Some native or introduced RNQPs can severely affect their intended use. In such cases, specific risk management measures can be defined to limit the infestation of pests. These measures may involve complying with tolerances checked during inspections of growing crops (Picard et al., 2019).

The San José scale (*Quadraspidiotus perniciosus* Comst.) is a species that originated in East Asia and was accidentally introduced to countries like the USA, Argentina, Australia, and New Zealand. This species can be found in the Palearctic and Nearctic regions. Many studies have been conducted on its prevalence and significance in various parts of the world. These include works by Konstantinova (1976), Baker (1977), Chowdhuri (1977), Kozár and Konstantinova (1981), Kozár and Drozdjak (1988), Davidson and Miller (1990), Kozár et al. (1994), and Mani et al. (1995).

According to a report by EPPO (2021) and CABI (2022), the San José scale has spread to 85 countries worldwide, representing 43.6% of the total countries. The San José scale is particularly harmful in Europe, where it has been found in thirty-four countries, representing 77.3% of the total number of countries affected. It is also present in Asia (56.3%) and South America (29%). Prevalence rates of the San José scale vary across continents, with Oceania (21.4%) and Africa (14.8%) having lower rates. The San José scale has been found in all countries in North America, and there is a greater risk of its spread in this region.

In Bulgaria, Dirimanov and Burov (1971) described for the first time in their publication that the San José scale was observed in 1953 in Vidin. Because of its 70-year presence in the country, the species is widespread and found in all regions.

The development of this pest is closely linked to weather conditions, particularly temperature, which plays a critical role and can cause significant harm or even death of trees (Beşleagă et al., 2009; Ivanov et al., 2023).

The study aimed to provide new information on the development of the San José scale (*Quadraspidiotus perniciosus* Comst.) in protected facilities like an insect-proof net house and shaded fields. This information will help prepare risk analyses and implement solutions to prevent plant damage in the production of planting material both locally and internationally.

MATERIALS AND METHODS

The research was conducted at the Fruit Growing Institute – Plovdiv, Bulgaria, between 2019 and 2021.

To achieve the aim of the study, in 2018, two experimental fields were constructed (Figure 1):

- The shaded field measures 15x30 m and is covered with a shading net made of polyethylene tape, type Raffia. The net is UV-stabilized and resistant to atmospheric conditions. It has a shading factor of 50% and is green, weighing 45 g/m^2.
- The insect-proof net field measures 7x50 m and is covered with an entomological net made of UV-resistant polyethylene. The net has a hole size of 0.28x0.78 mm and a weight of 105 g/m^2. It is colored white and offers a low shading percentage of 9-10%.

The observation was conducted on three fruit species: apples (*Malus domestica* Borkh), plums (*Prunus domestica* L.), and sweet cherries (*Prunus avium* L.) (Figure 2).

The following grafting technique was used: winter grafting using the "stratification" methods. One hundred pieces were grafted using the grafting technique.

Winter grafting was done between 15 ÷ 25.01, utilizing the Bench grafting method. The grafting technique used was the whip-and-tongue grafting of three buds on the cuttings, with the substrate at 30 cm high. The fixation between the rootstock and the scion was conducted using horticultural strapping tape, which resulted in the absence of aeration at the grafting site. The free end of the graft was immersed in paraffin.

Figure 1. Experimental fields

Figure 2. Fruit species: apple (*Malus domestica* Borkh), plum (*Prunus domestica* L.), and sweet cherry (*Prunus avium* L.) produced in containers

Grafting by the "stratification" method (Figure 3)

The stratification room is a specially designed room that is used to regulate temperature through a sensor. In this room, plants were tied in groups of ten and put in wooden boxes that measured 60/70 cm. The roots of the plants were covered with sand. The wooden boxes were then placed in the stratification room, where the temperature was kept at a constant 20 °C and humidity level of 80-90%. Wooden boxes were covered with polyethylene film to ensure proper humidity levels for the first 10 days. This process is based on the research by Dimitrov et al. (2022a, b).

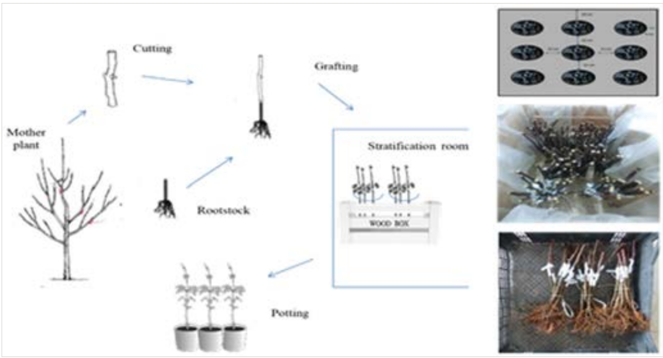

Figure 3. Schematic representation of grafting by the stratification method

The plants were then planted in 10-litre containers filled with a 2:1 mixture of peat and perlite and transferred to a glass greenhouse to adapt. On 01.04, they were moved to the observation fields.

Throughout the growing season, the plants received 3 applications of soil nutrition at a dose of N 1.3 P 0.3 K 0.7 Mg 0.1. YARA's Kristalon combined fertilizer, which contains N (20%) - P_2O_5 (5%) - K_2O (10%) - MgO (2%), was used for fertilization due to its balanced nutrient composition that promotes healthy plant growth. The soil moisture in the containers was kept at the maximum field moisture content, and the irrigation rate was adjusted based on temperature and precipitation.

The plants were irrigated using a drip system, with one drip generator per pot at a flow rate of 2 l/h. Plant height was measured by placing a stake next to the plant and using a tape measure.

Direct reporting on individual plants "in situ"

The pest San Josè scale (*Quadraspidiotus perniciosus* Comst.) was subjected to monitoring the risk of occurrence and spread. Observations and reports were carried out on three variants:

- Variant 1: Infested plants due to the use of infested cuttings for propagation.
- Variant 2: Infested plants due to pest migration from infested to uninfested plants.
- Variant 3: Uninfested plants (control).

Each plant was carefully observed, and the number of individuals, along with their stage of development, were recorded. Insects of exceedingly small sizes were counted by scale due to the difficulty of enumeration. A five-scale system (methodology adopted by Bakhetia and Sandhu, 1973) was used in the study:

- 0 – no colonies on plants;
- 1 – traces of colonies on plants;
- 2 – colonies covering an insignificant part of the leaves or branches of the plants (up to 10%);
- 3 – colonies covering a significant part of the leaves or branches of the plants (from 11% to 25%);
- 4 – dense colonies covering a significant part of the leaves or branches of the plants (from 26% to 50%);
- 5 – aphid colonies are numerous and cover a greater part (over 51%) of the plant surface.

% damaged plants (simple triple rule):

$$P = (A \times 100) / B$$

where:

P – percentage of damaged (attacked) plants;

A – number of damaged plants;

B – number of all plants examined.

Coefficient of harmfulness (calculated by equation):

$$K = [(a - b) / a] \times 100$$

where:

K – Coefficient of harmfulness;

a – number of undamaged plants;

b – number of damaged plants.

Data collection and analysis

The readings were conducted at the end of the growing season on twenty plants in three replicates of each variant. Data was collected, and statistical analysis was performed using Duncan's new multiple range test (MRT) (Duncan, 1955; Harter, 1960). The software used in the study was "R-4.0.4" in combination with "RStudio-1.4" and the installed package "agricolae 1.3-3" (Mendiburu, 2015).

RESULTS AND DISCUSSION

The growth of fruit tree species such as apple (*Malus domestica* Borkh.), plum (*Prunus domestica* L.), and sweet cherry (*Prunus avium* L.) fruit trees was negatively affected by the San José scale (*Quadraspidiotus perniciosus* Comst.). This effect was observed in all three species (Table 1).

Among these fruit species, apple fruit trees had the highest total vegetative growth for uninfested plants, with 246.7 cm, followed by plums, with 214.7 cm, and sweet cherries, with 103.8 cm. No statistically proven differences were found between the observation years 2019 - 2021.

In the apple fruit trees, statistically proven differences were found between fields using a net and a non-shaded field.

Table 1. Influence of the development of the San José scale (*Quadraspidiotus perniciosus* Comst.) on the total vegetative growth of apple (*Malus domestica* Borkh.), plum (*Prunus domestica* L.) and sweet cherry (*Prunus avium* L.) fruit tree species in an insect-proof net house, shaded field, and non-shaded field

Fruit tree species	Fields of observation**	Year	Total vegetative growth				
			Non-infested plants	Infested plants during propagation (infested cuttings)	Deviation %	Infested plants due to migration	Deviation %
Apple (*Malus domestica* Borkh.)		2019	308.8^{a*}	287.0^{a}	6.3	305.4^{a}	1.1
		2020	300.4^{a}	291.5^{a}	3.0	294.7^{ab}	1.9
		2021	249.8^{abc}	237.9^{abc}	5.7	246.6^{abc}	1.3
	Average		286.3	272.1	5.0	282.3	1.4
		2019	283.5^{ab}	260.0^{ab}	8.2	279.3^{ab}	1.5
		2020	263.5^{ab}	240.0^{abc}	8.8	247.2^{abc}	1.6
		2021	243.5^{abc}	220.0^{cde}	9.6	235.8^{abcd}	3.2
	Average		263.5	240.0	8.9	258.1	2.0
		2019	215.2^{bcd}	191.2^{cde}	11.0	194.3^{bcd}	3.9
		2020	190.2^{cd}	166.2^{de}	12.5	169.3^{cd}	4.4
		2021	165.2^{d}	141.2^{e}	14.5	144.3^{d}	5.1
	Average		190.2	166.2	12.7	181.7	4.4
Plum (*Prunus domestica* L.)		2019	274.8^{a}	250.2^{a}	9.0	269.2^{a}	2.0
		2020	197.4^{bc}	179.6^{bc}	8.2	192.0^{bc}	2.7
		2021	203.0^{bc}	180.1^{bc}	10.9	195.7^{bc}	3.6
	Average		225.1	203.3	9.4	219.0	2.7
		2019	262.0^{ab}	240.4^{ab}	8.3	253.6^{ab}	3.2
		2020	197.^{6bc}	180.1^{bc}	9.1	186.9^{bc}	5.4
		2021	194.8^{bc}	165.2^{c}	15.8	180.9^{c}	7.1
	Average		218.1	195.2	11.1	207.2	5.0
		2019	232.2^{abc}	205.4^{abc}	11.6	226.3^{abc}	2.5
		2020	192.8^{bc}	167.2^{c}	13.7	185.5^{bc}	3.8
		2021	177.4^{c}	153.8^{c}	15.8	167.5^{c}	7.1
	Average		200.8	175.5	13.0	193.1	3.8

Continued. Table 1.

Fruit tree species	Fields of observation**	Year	Non-infested plants	Total vegetative growth			
				Infested plants during propagation (infested cuttings)	Deviation %	Infested plants due to migration	Deviation %
		2019	124.9^{a}	112.2^{a}	10.8	118.6^{a}	5.0
		2020	101.4^{ab}	80.1^{b}	22.3	94.1^{ab}	7.2
		2021	102.5^{ab}	76.8^{b}	25.3	96.4^{ab}	6.0
	Average		109.6	89.7	19.5	103.1	6.0
		2019	116.4^{ab}	94.1^{ab}	18.9	109.9^{ab}	5.6
		2020	98.9^{ab}	87.4^{ab}	11.3	91.2^{ab}	7.8
Sweet cherry (*Prunus avium* L.)		2021	101.4^{ab}	74.4^{b}	26.2	91.5^{ab}	9.8
	Average		150.5	85.3	18.8	97.5	7.6
		2019	96.5^{b}	76.6^{b}	20.9	89.9^{b}	6.8
		2020	101.4^{ab}	87.4^{ab}	14.5	96.7^{ab}	4.7
		2021	91.4^{b}	71.6^{b}	21.2	82.7^{b}	9.5
	Average		96.4	78.5	18.9	89.7	6.9

* Mean values marked with the same letter are not significantly different according to Duncan's test ($P < 0.05$).

** Mean values were compared between observation fields.

The highest total vegetative growth was observed in the insect-proof net house, which was 286.3 cm, followed by 263.5 cm in the shaded field and 190.2 cm in the non-shaded field. There was a positive correlation between uninfested plants and plants with the presence of the pest. In infested plants (infested cuttings), the highest percentage was found in plants grown in a non-shaded field (12.7%), compared to 8.9% in a shaded field and 5.0% in an insect-proof net house. The percentage of plants infested due to natural migration of the species was significantly lower - 4.4% in a non-shaded field, 2.0% in a shaded field, and 1.4% in an insect-proof net house.

For stone fruit species, no statistically proven differences were found between observation fields. In plum species, the average vegetative growth of uninfested plants in the different fields was 225.1 cm in the insect-proof net house, followed by 218.1 cm in the shaded field and 200.8 cm in the non-shaded field. Significantly lower results were recorded for sweet cherry fruit trees - 109.6 cm in an insect-proof net house, 105.5 cm in a shaded field, and 96.4 cm in a non-shaded field. The results show a continuation of the trend for higher scores in the insect-proof net house.

As a result of the development of the pest, a higher percentage of damage was again reported in plants infested during propagation compared to those infested by migration of the species. In plum fruit trees, due to the use of infested cuttings, the highest percentage was observed in a non-shaded field - 13.0%, followed by 11.1% in a shaded field and 9.4% in an insect-proof net house. Significant differences were found in sweet cherry species. The highest percentage was found in an insect-proof net house - 19.5% and, respectively, 18.9% in a non-shaded field and 18.8% in a shaded field. In plants infested because of the natural migration of the pest, the percentages were significantly lower. Higher percentages were found for sweet cherry fruit trees, respectively, 7.6% in a shaded field, 6.9% in a non-shaded field, and 6.0% in an insect-proof net house, compared to plum species – 5.0% in a shaded field, 3.8% in a non-shaded field, and 2.7% in an insect-proof net house.

The results obtained show that the plant host on which the pest develops influences the total vegetative growth of fruit trees. In addition to the climatic factor temperature, the presence of the San José scale negatively affects the development of fruit trees.

The following data was recorded on a five-rate scale to determine the extent of damage to fruit crops. The highest score was observed in an insect-proof net house for all three fruit crop species (Table 2).

Apple fruit trees had an average score of 2.7 from 2019 to 2021, with 2.2 for those grown in shaded fields and 2.1 for those in non-shaded fields. The year 2020 showed the highest values for this research period.

Plum fruit trees (*Prunus domestica* L.) had the highest average score of 4.1 over the three-year research period, with the highest score of 4.6 in the insect-proof net house and 2.4 in the non-shaded field in 2020. The score for 2019 was 3.4, which was higher than the other years. In the sweet cherry species, the highest score of 3.8 was recorded in the insect-proof net house, followed by 2.6 in the shaded field and 2.1 in the non-shaded field.

In a study of the apple fruit species (*Malus domestica* Borkh.) grown in an insect-proof net house (Figure 4), it was observed that most of the plants reported a damage rating between 2 and 3 rates. In contrast, in a shaded field, the rating was between 1 and 2 rates. In a non-shaded field, the damage rating was evenly distributed from 1 to 3.

Table 2. Degree of damage by San José scale (*Quadraspidiotus perniciosus* Comst.) on apple (*Malus domestica* Borkh.), plum (*Prunus domestica* L.), and sweet cherry (*Prunus avium* L.) fruit tree species in container growing plants in the insect-proof net house, shaded field, and non-shaded field

Fruit tree species	Year	Insect-proof net house	Shaded field	Non-shaded field
Apple (*Malus domestica* Borkh.)	2019	2.6	2.0	1.6
	2020	3.0	2.6	2.6
	2021	2.6	2.0	2.0
	Average	2.7	2.2	2.1
Plum (*Prunus domestica* L.)	2019	3.8	3.4	1.8
	2020	4.6	3.0	2.4
	2021	4.0	3.2	1.0
	Average	4.1	3.2	1.7
Sweet cherry (*Prunus avium* L.)	2019	3.4	2.8	1.4
	2020	4.0	2.6	2.0
	2021	4.0	2.4	2.8
	Average	3.8	2.6	2.1

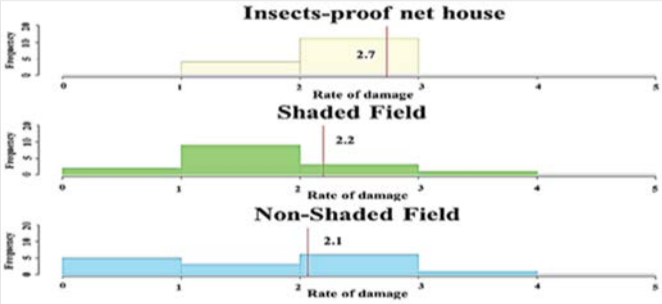

Figure 4. Frequency of damage by San José scale (*Quadraspidiotus perniciosus* Comst.) on apple (*Malus domestica* Borkh.) fruit tree species in the insect-proof net house, shaded field, and non-shaded field under container cultivation

Interestingly, while the insect-proof net house had a higher overall damage score, the frequency of plants with a rating of 4 was significantly lower.

In the species of fruit tree plum (*Prunus domestica* L.), the plants in the insect-proof net house showed the highest score for damage caused by the San José scale (*Quadraspidiotus perniciosus* Comst.). This damage showed a trend of increasing frequency from 2 to 5 rates, as shown in Figure 5.

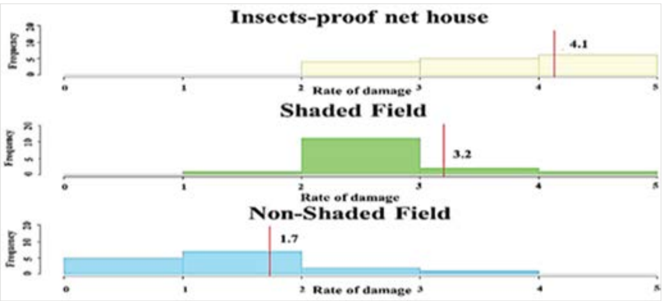

Figure 5. Frequency of damage of San José scale (*Quadraspidiotus perniciosus* Comst.) on plum (*Prunus domestica* L.) fruit tree species in the insect-proof net house, shaded field, and non-shaded field under container cultivation

A clear peak in frequency was observed at rate 2 in a shaded field, while in a non-shaded field, the frequency of damage was evenly distributed from 0 to 2 rates. These data suggest that the density of the pest was significantly higher in the insect-proof net house, indicating that the San José scale thrives in such an environment. In a study by Ivanov (2022), a comparative analysis of the climatic conditions during the production of planting material proves a significant increase in temperature under shaded and entomological nets. In observing the biology of the pests, Ivanov et al. (2023) found earlier development of the San José scale under the entomological and shaded net.

In the sweet cherry tree species (*Prunus avium* L.), a pattern was observed in both shaded and non-shaded fields, as well as in the stone plum species. The highest incidence of damage was found to be at a rate of 3 in an insect-proof net house, as shown in Figure 6.

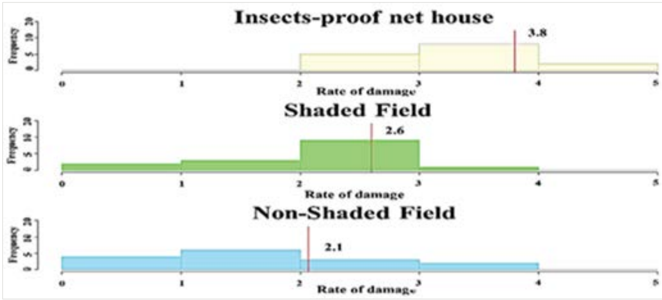

Figure 6. Frequency of damage by the San José scale (*Quadraspidiotus perniciosus* Comst.) to sweet cherry (*Prunus avium* L.) fruit tree species in the insect-proof net house, shaded field, and non-shaded field under container cultivation

Table 3 shows that although apple fruit trees in insect-proof net houses had a higher damage score, a significantly higher percentage of infested plants was found in a non-shaded field (43.3%), compared to 25.0% in the insect-proof net house and 28.3% in a shaded field. In the case of stone fruit species, a significantly higher percentage of infested plants (41.7% for plum and 31.7% for sweet cherry) was recorded in an insect-proof net house.

The harmfulness of the apple fruit species (*Malus domestica* Borkh.) was calculated based on a complex coefficient. The insect-proof net house had a harmfulness score of 75.0% due to the high frequency of harm in the upper range (Table 4). In a shaded field, the coefficient was 71.7%, while in a non-shaded field, it was 56.7%.

In the stone fruit species, a higher percentage of damage was reported in a non-shaded field. For plums, it was 66.7%, and for sweet cherries, it was 70.0%.

The high coefficients of harmfulness reported for all three fruit species indicate the exceptional harmfulness of the San José scale (*Quadraspidiotus perniciosus* Comst.).

Table 3. Degree of damage by San José scale (*Quadraspidiotus perniciosus* Comst.) on apple (*Malus domestica* Borkh.), plum (*Prunus domestica* L.), and sweet cherry (*Prunus avium* L.) fruit tree species in container growing plants in the insect-proof net house, shaded field, and non-shaded field

Fruit tree species	Year	Insect-proof net house	Shaded field	Non-shaded field
Apple (*Malus domestica* Borkh.)	2019	30.0	35.0	50.0
	2020	25.0	30.0	45.0
	2021	20.0	20.0	35.0
	Average	25.0	28.3	43.3
Plum (*Prunus domestica* L.)	2019	40.0	35.0	30.0
	2020	50.0	40.0	35.0
	2021	35.0	30.0	35.0
	Average	41.7	35.0	33.3
Sweet cherry (*Prunus avium* L.)	2019	35.0	40.0	35.0
	2020	35.0	30.0	30.0
	2021	25.0	25.0	25.0
	Average	31.7	31.7	30.0

Table 4. Coefficient of the harmfulness of San José scale (*Quadraspidiotus perniciosus* Comst.) on apple (*Malus domestica* Borkh.), plum (*Prunus domestica* L.), and sweet cherry (*Prunus avium* L.) fruit trees in container cultivation of plants in an insect-proof net house, shaded field, and non-shaded field

Fruit tree species	Year	Insect-proof net house	Shaded field	Non-shaded field
Apple (*Malus domestica* Borkh.)	2019	70.0	65.0	50.0
	2020	75.0	70.0	55.0
	2021	80.0	80.0	65.0
	Average	75.0	71.7	56.7
Plum (*Prunus domestica* L.)	2019	60.0	65.0	70.0
	2020	50.0	60.0	65.0
	2021	65.0	70.0	65.0
	Average	58.3	65.0	66.7
Sweet cherry (*Prunus avium* L.)	2019	65.0	60.0	65.0
	2020	65.0	70.0	70.0
	2021	75.0	75.0	75.0
	Average	68.3	68.3	70.0

CONCLUSIONS

New added information has been obtained on the development of the San José scale *Diaspidiotus (Quadraspidiotus) perniciosus* Comstock in protected facilities like an insect-proof net house and shaded fields. This information will help prepare risk analyses and implement solutions to prevent plant damage in the production of planting material both locally and internationally.

Because of the development of the San José scale (*Quadraspidiotus perniciosus* Comstock), a higher percentage of damage was reported in plants grown with infested propagating material compared to plants grown during the species' migration.

Calculating the complex coefficient of harmfulness of the San José scale in the apple fruit species (*Malus domestica* Borkhausen), a significantly higher percentage was calculated in the insect-proof net house - 75.0%, due to the high score and frequency of harmfulness in the upper range. In the shaded field, this coefficient was 71.7%, and in the non-shaded field, 56.7%.

The pests' high damage coefficients indicate an extreme risk of infestation when using nets to produce planting material.

Although the pests are considered absent in protected facilities, their introduction is possible when an infested host is introduced. The harmfulness of the pests can be reduced after strict compliance with the measures to limit their spread, such as visual monitoring of the materials used for the propagation of fruit species.

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