Overview of Silver Fir Woolly Adelgid in the Pacific Northwest

Gary Chastagner and Marianne Elliott
Washington State University
chastag@wsu.edu; melliott2@wsu.edu
March 2026

During the past 20 to 30 years there has been an increase in production of Nordmann and Turkish fir Christmas trees in the Pacific Northwest (PNW). These species have excellent postharvest moisture and needle retention when displayed in water. They are tolerant or have limited susceptibility to several pests and pathogens that attack North American hosts, including *Phytophthora* root rot, *Annosus* root rot, spider mites, and balsam woolly adelgid. Currently, these Eurasian species are the third most widely-planted Christmas tree in the PNW. Their limited susceptibility to common diseases and pests has also allowed growers to produce them with little or no applications of fungicides and insecticides. Grower observations also suggest they may have better drought tolerance than commonly-grown North American species.

Nordmann fir has been widely grown as Christmas trees in Denmark for many decades. Throughout Central and Northern Europe, the silver fir woolly adelgid [*Adelges* (*Dreyfusia*) *nordmannianae*] is a serious pest on Nordmann fir. The silver fir woolly adelgid is native to the Caucasus region, which is also the native range of Nordmann and Turkish firs. In its center of origin, the insect is controlled by a number of natural predators. This pest has rarely been seen in the PNW. In 2010, it was initially detected on a few Nordmann fir trees in a 2004 Christmas tree genetic planting located at the Washington State University Puyallup Research and Extension Center (PREC). This planting contained approximately 750 trees from 12 families of Nordmann fir and three families of Turkish fir. In the same year it was also detected on Nordmann fir trees in a commercial Christmas tree plantation and a landscape site in the south Puget Sound region. Branch samples with suspected adelgid symptoms were obtained from an additional 25 growers in WA and OR, but no evidence of the silver fir woolly adelgids was found on any of the samples. Fifteen years later during 2025, this pest was detected on trees at WSU PREC and at a few commercial Christmas tree plantations in the Puget Sound region.

Given the potential impact the silver fir woolly adelgid could have on the production of Nordmann fir Christmas trees in the PNW, research was conducted relating to the life cycle of this pest, its spread, host susceptibility, and management following its initial detection on trees at WSU PREC in 2010. A summary of information from that research follows.

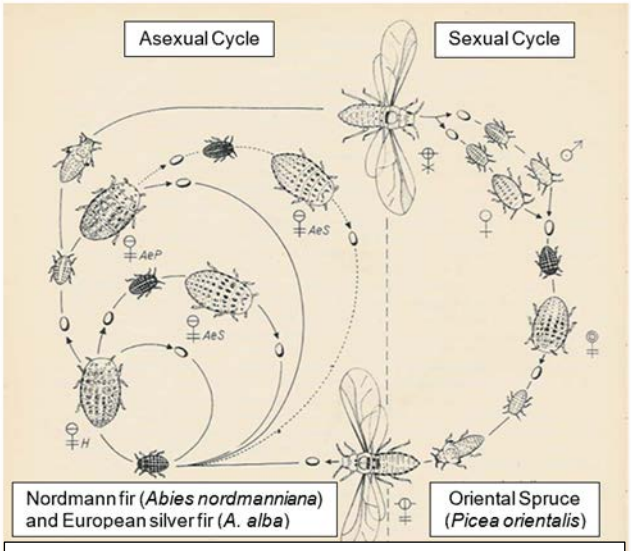


Figure 1. Silver fir woolly adelgid (*Adelges nordmannianae*) life cycle.

Life cycle: The silver fir woolly adelgid has a complex life cycle (Figure 1). In its natural range in the Caucasus region (Russia, Georgia, and Turkey), this pest alternates between Oriental spruce (*Picea orientalis*), where the sexual stage occurs, and various *Abies* species such as Nordmann fir which

host the asexual stage. In areas where Oriental spruce is not present, it persists as an asexual population that reproduces parthenogenetically (asexually) and does not require the sexual stage to complete its life cycle. Depending on temperatures during the growing season, there may be 2 to 6 generations of this pest, making control difficult.

The life cycle of the silver fir woolly adelgid was monitored on infested Nordmann fir trees at WSU PREC from 2013 through 2016 to determine how many generations of this pest occur during the year. Branches were collected on a regular schedule and examined under a dissecting scope to determine the development of adelgid life stages throughout the year. All potential life stages of the adelgid that occur on their *Abies* host were observed on the Nordmann fir trees at WSU PREC (Figure 2). There was a consistent progression through the life stages and there were two generations per growing season (Table 1). Overwintering stem mothers started laying eggs in late March. Egg hatch and 1st generation crawlers began to emerge in early April, about 1 week prior to initial bud break on Nordmann fir. The winged form was only evident on trees during 2013 and 2014.

Figure 2. Life stages of adelgids observed on trees at WSU PREC. Overwintered stem mothers with eggs (left), crawlers (center), winged form with summer stem mother (right).

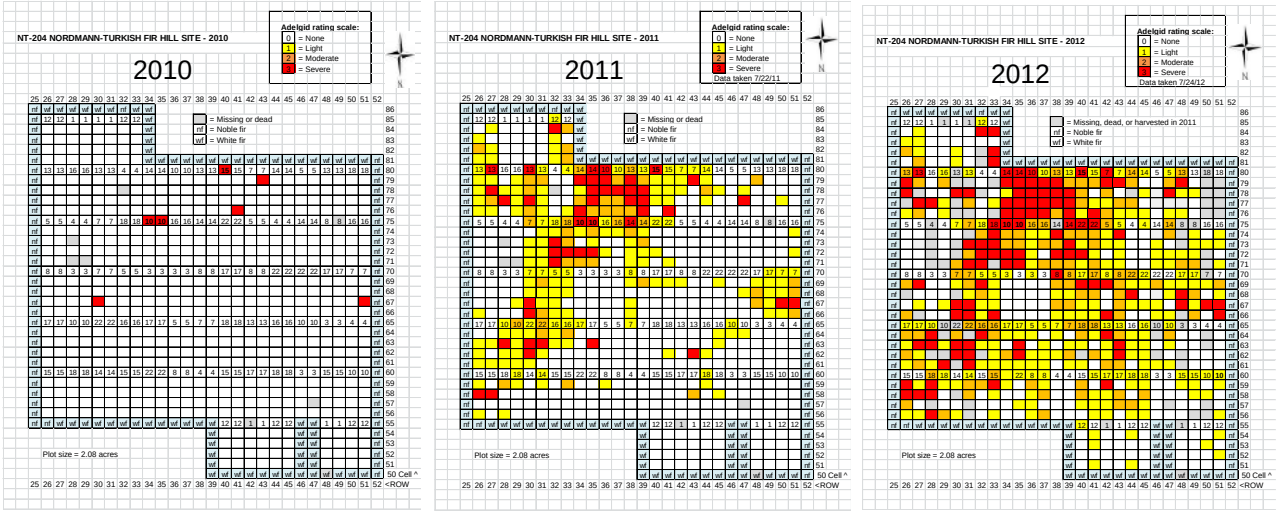
For each of the life stages observed, the growing degree days (GDD base 41, where GDD is the number of degrees above the base temperature for each day) were calculated from March 1st using the following formula: GDD = (Max Daily Temp + Min Daily Temp)/2 – 41. The initial appearance of the 1st generation crawlers ranged from 217 to 380 GDD (avg. 285) over the 4 years (Table 1). Following bud break, which corresponded to 354 to 437 GDD (avg. 380), the crawlers moved onto and fed on the newly emerging growth (Figure 3). This indicates that growers could utilize GDD to optimize their adelgid control treatments.

Figure 3. New growth severely infested with adelgid crawlers.

Table 1. Adelgid life cycle timeline on Nordmann fir at Puyallup								
	2013		2014		2015		2016	
Life Stage	Date	GDD	Date	GDD	Date	GDD	Date	GDD
1st generation eggs	26 Mar	77	26 Mar	116	30 Mar	211	28-Mar	179.8
First crawlers	3 Apr	243	9 Apr	221	13 Apr	297	14 Apr.	380
Bud break	30 Apr	371	1 May	437	20 Apr	361	11 Apr	354
2nd gen. eggs	7 June	996	30 May	914	7 May	543	16 May	913
2nd gen. crawler	13 June	1103	30 May	914	-	-	13 June	1447
Winged form	21 May	724	30 May	914	n/a		n/a	

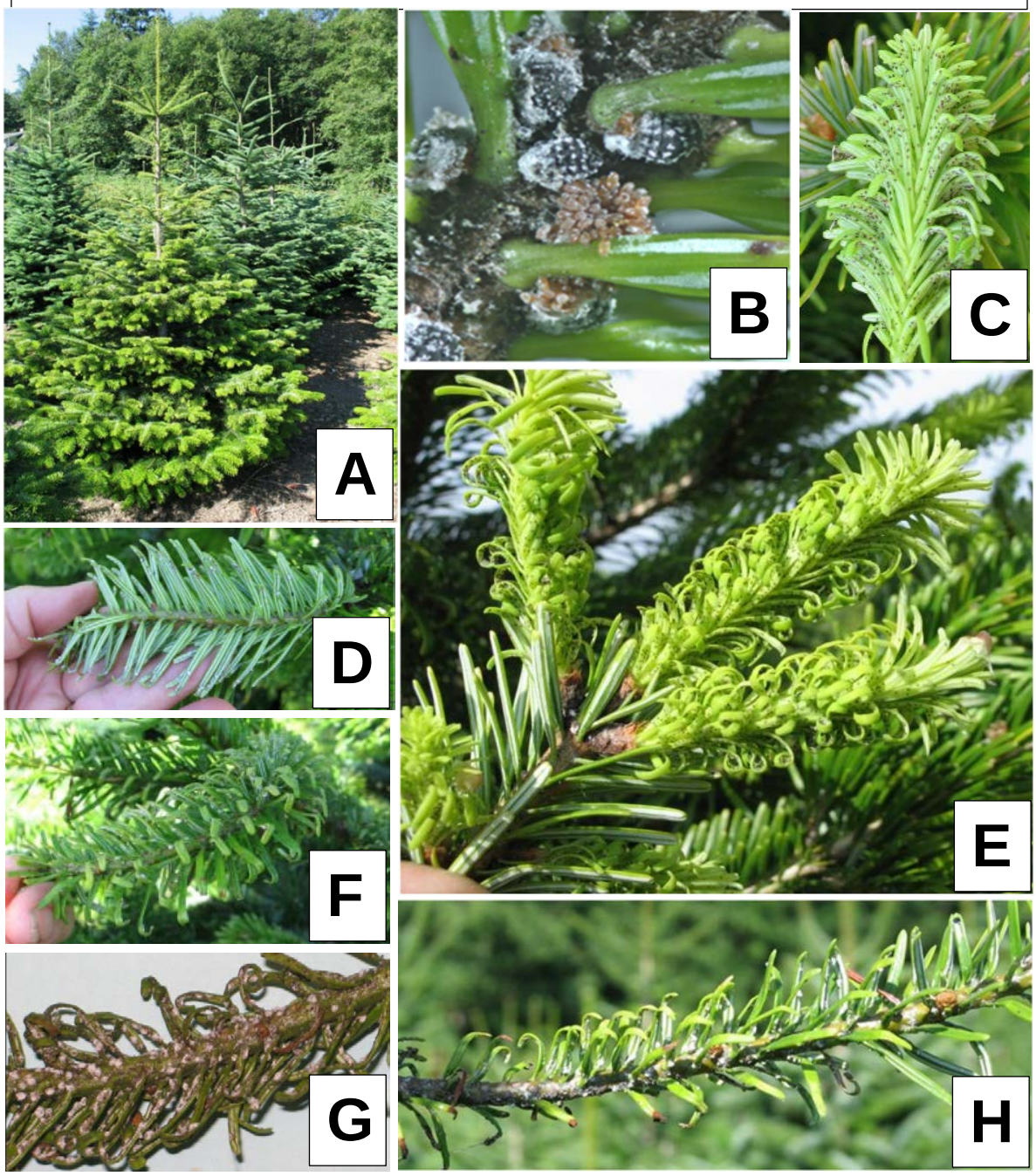
Spread within Nordmann/Turkish fir planting: In 2010, adelgid damage was detected on about 1% of the Nordmann fir trees in the 2004 genetic common garden Nordmann/Turkish fir Christmas tree planting at WSU PREC. By 2012, 61% of the Nordmann fir trees in this planting were badly infested and 16% were unmarketable (Figure 4) because of the large numbers of crawlers that had attacked the foliage, which led to discoloration and severe distortion of the needles on affected shoots.

Figure 4. Spread and severity of silver fir wooly adelgid damage on Nordmann and Turkish fir trees at WSU Puyallup between 2010-2012.



Symptoms: The silver fir woolly adelgid primarily attacks newly emerging shoots and symptoms result from the feeding of this pest on newly emerging shoots and needles. Infested needles are often chlorotic, shortened, and twisted downwards. The severity of symptoms varies depending on the level of infestation. Needles on lightly infested shoots may be the same length as non-infested needles, while elongation of needles on highly infested shoots is very stunted and the shoots will be deformed, shortened, brown, and dry (Figure 4). While symptoms caused by the silver fir woolly adelgid are evident year-round, spring is an excellent time to monitor fields to determine if this pest is present and make decisions about controlling it. Look for trees with light green to yellow foliage and then check for symptoms and life stages of the adelgid on the shoots and needles.

Figure 4. Symptoms associated with silver fir wooly adelgid infestation of Nordmann fir: **A** – tree with yellow, chlorotic foliage, **B** – waxy-covered stem mother adelgids producing eggs prior to bud break, **C** – newly emerged needles infested with crawlers, **D** - normal appearing needles on lightly infested shoot, **E** - distorted and curled needles on highly infested shoot, **F** – distorted and chlorotic needles on moderately infected shoot, **G** – severely infested shoot with distorted needles and waxy covered adelgids, and **H** - distorted needles with waxy-covered adelgids at the bases of needles.



Variation in susceptibility of Nordmann/Turkish fir trees in 2004 planting - The adelgid damage was originally observed in a 2004 replicated genetic common garden planting at Puyallup of Nordmann and Turkish fir seed sources from Denmark and Turkey. The planting included 12 sources of Nordmann fir and 3 sources of Turkish fir. Ten trees from each source were planted in each of five blocks. After the original adelgid observation in 2010, changes in the level of damage were evaluated yearly from 2014 through 2016. Overall damage on each tree was rated on a scale of 0 to 3, with 0 indicating no damage and 3 indicating an unmarketable tree. In spring 2015, before the start of the growing season, approximately half of the trees were thinned out because of crowding in this plot. The remaining trees were rated for adelgid damage at the end of the 2015 and 2016 growing seasons to determine if there were changes in damage severity on different seed sources. The 2014 and 2015 ratings indicated that there were significant differences in susceptibility between sources of Nordmann fir, but only limited damage occurred on any of the Turkish fir (Table 2). The 2014 and 2015 data were subjected to Spearman Rank Order analysis to determine if relative susceptibility of sources was the same in both years. There was a highly significant correlation ($P = 0.004$) between the susceptibility rankings in 2014 and 2015. One of the most striking findings was the apparent natural collapse of the adelgid population and the limited damage that occurred on in 2016 (Table 3). The reason is unclear, but additional studies might help to determine if this collapse was due to the thinning of trees or the buildup of natural predators.

Host susceptibility of *Abies* species: During 2013, 2014, and 2015, data were collected on the susceptibility of 13 different *Abies* species in a replicated, mixed demonstration planting located adjacent to the adelgid-infested 2004 Nordmann/Turkish fir genetic trial described above. In addition to adelgids that spread naturally from the adjacent 2004 planting, in spring 2013, small branches with overwintering adelgid stem mothers were harvested from infested trees and tied to a branch on each tree within this planting. The extent of needle curling and damage on each tree was then rated in the summer/fall of 2013, 2014, and 2015 (Table 3). Curling was rated on a scale of 0 to 5, with 0 = no curling or evidence of adelgids, 1 = the tips of a few needles bent throughout the branches, 2 = some needles beginning to curl, with bent needles evident throughout the branch, 3 = almost all needles bent, many beginning to curl with slight yellowing, 4 = almost all needles curling with a yellow discoloration and damage easily visible from the top of the branch, and 5 = most needles curled throughout the branch and many are yellow or brown. Overall damage on each tree was also rated on a scale of 0 to 3 as previously described.

Data collected in 2013 showed slight adelgid infestations on some species throughout the plot. Of the 13 species, the highest curling and damage ratings occurred on the Nordmann and European silver firs (*Abies alba*), which are the principal host of this pest in Europe. Fraser (*Abies fraseri*), Canaan (*Abies balsamea* var. *phanerolepis*) balsam (*Abies balsamea*), Korean (*Abies koreana*), Nikko (*Abies homolepis*), and Turkish fir trees exhibited a very low level of curling at the site where the infested branch was secured to the tree in 2013 (Table 3). A year later, there was no evidence of adelgids on these trees, suggesting they were not able to overwinter and reproduce on any species in the planting other than the Nordmann and European silver firs (Table 3). Data in 2015 confirmed the 2013 and 2014 data, with the exception of slight damage on Nikko and Turkish fir in 2015. Over the three-year period, the highest level of damage occurred on the Nordmann and European silver firs. Since very little or no damage was observed on the other species, it would indicate there is limited risk of this adelgid attacking most of the commonly grown North American *Abies* species of Christmas trees grown in North America.

Table 2. Susceptibility of 12 families of Nordmann fir and three families of Turkish fir in a 2004 genetic trial at WSU PREC to the silver fir woolly adelgid.

		Average Damage Rating[1]					
Number	Source	2014		2015		2016	
8	Nordmann Fir, Denmark Statsskovenes Planteavlsstation	2.55	a	2.00	a	0.19	a
14	Nordmann Fir, Denmark Klon Hedeselskabet Forest Seed Center	2.38	a	1.13	abc	0.00	a
13	Nordmann Fir, Denmark Klon Hedeselskabet Forest Seed Center	2.26	a	0.60	cde	0.10	a
22	Nordmann Fir, Denmark Statsskovenes Planteavlsstation	2.22	a	1.12	bcd	0.13	a
17	Nordmann Fir, Denmark Klon Hedeselskabet Forest Seed Center	2.16	ab	1.90	ab	0.05	a
10	Nordmann Fir, Denmark Statsskovenes Planteavlsstation	2.15	ab	0.80	cde	0.00	a
18	Nordmann Fir, Denmark Klon Hedeselskabet Forest Seed Center	2.03	abc	0.93	cd	0.00	a
15	Nordmann Fir, Denmark Klon Hedeselskabet Forest Seed Center	1.91	abcd	1.43	abc	0.00	a
7	Nordmann Fir, Denmark Statsskovenes Planteavlsstation	1.80	abcd	1.46	abc	0.00	a
5	Nordmann Fir, Artvin, Yayla	1.30	bcd	1.00	cd	0.04	a
12	Nordmann Fir, Denmark Statsskovenes Planteavlsstation	1.19	cd	0.93	cd	0.00	a
16	Nordmann Fir, Denmark Klon Hedeselskabet Forest Seed Center	1.09	de	0.54	de	0.13	a
4	Turkish Fir, Adapazan, Akyazi	0.26	ef	0.33	de	0.00	a
3	Turkish Fir, Adapazan, Hendek	0.23	ef	0.44	de	0.00	a
1	Turkish Fir, Bursa, Komursu	0.11	f	0.00	e	0.00	a

[1] Overall damage was rated on a scale of 0 to 3, with 0 indicating no damage and 3 indicating an unmarketable tree. Numbers with the same letter are not significantly different, $P<0.05$, Tukey's Studentized Range (HSD) Test.

Table 3. Average damage ratings of 13 Abies species in a replicated demonstration planting.

	2013		2014		2015	
Species	Curling	Damage	Curling	Damage	Curling	Damage
California Red Fir	0	0	0	0	0	0
Noble Fir	0	0	0	0	0	0
Grand Fir	0	0	0	0	0	0
Fraser Fir	0.1	0	0	0	0	0
Shasta Fir	0	0	0	0	0	0
White Fir	0	0	0	0	0	0
Canaan Fir	0.1	0.1	0	0	0	0
Balsam Fir	0.9	0.2	0	0	0	0
Korean Fir	0.1	0	0	0	0	0
Nikko Fir	0.1	0	0	0	0	0.1
Turkish Fir #4	0.3	0.1	0	0	0	0.2
European Silver Fir	0.8	0.7	0.3	0.5	0.4	1.5
Nordmann Fir #13	1.4	1.0	1.8	1.6	1.4	1.5

[1]Curling was rated on a scale of 0 to 5, with 0 = no curling or evidence of adelgids and 5 = most needles are curled throughout the branch and many of the needles have a yellow or brown color. Overall damage was rated on a scale of 0 to 3, with 0 indicating no damage and 3 indicating an unmarketable tree.

Potential risk of adelgid spread via the movement of infested Christmas trees and boughs: Adelgids are known to spread via wind, human activity, birds and infested live plants. Little is known about the risk of spreading silver fir woolly adelgids from one location to another via the movement of infested cut Christmas trees or boughs. As a result, controlled studies were conducted during the 2013-14 and 2014-15 harvest seasons to determine the risk that adelgids could be spread from one location to another via the movement of infested cut Christmas trees or boughs (Figure 5). Three sets of branches, consisting of a branch from each of five heavily infested Nordmann fir trees, were harvested on December 5, 2013 and December 2, 2014, respectively. One set was stored in ventilated plastic crates outdoors. The other two sets were displayed indoors at 20C until early January; one set with their bases in water and the other dry. Following the indoor display period, both sets of branches were placed in ventilated plastic crates and stored outdoors with the others. A baseline check consisted of branches that remained on the infested source trees and were observed regularly. The effect of the different display and storage conditions on adelgid survival was determined by periodically examining the branches to determine the adelgid's viability and life stages through early April.

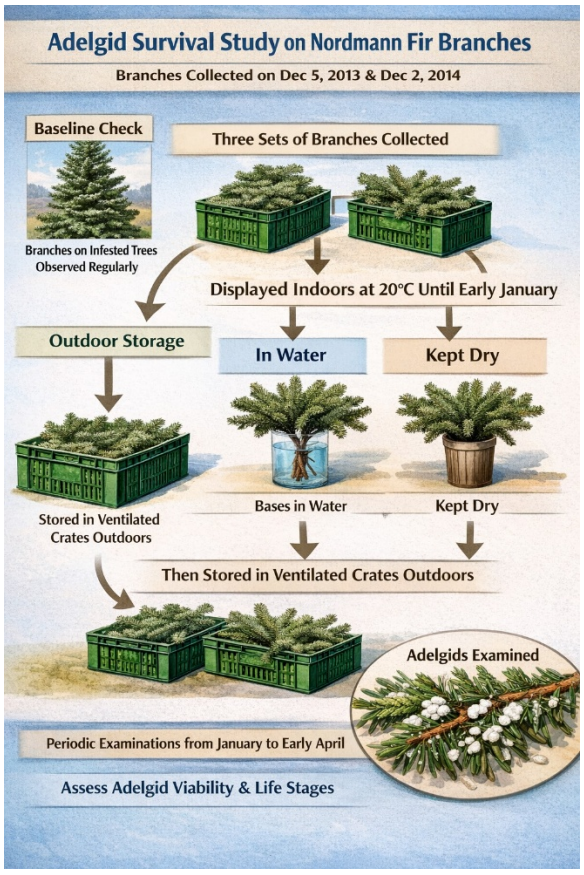


Figure 5. Infographic describing the adelgid survival postharvest study on Nordmann fir.

No evidence of overwintering stem mother (SM) adelgid mortality was evident on any of the detached branches in early January, except for a few branches that were displayed dry in the 2013-14 test. Unlike 2013-14, in the 2014-15 test none of the adelgids produced eggs on any of the indoor-displayed branches or when the branches were displayed outdoors (Table 4). This may have been due to differences in the environmental conditions that occurred prior to harvest in 2013-14 and 2014-15. Stem mother adelgids on the check branches that were not removed from the source trees began laying eggs about 3 weeks prior to bud break in late March, 2014 and 2015 March 26 and 30, respectively and the first crawlers were evident 19 days later (April 9 and 13, respectively). None of the SM adelgids survived on the detached branches that were stored outdoors, or displayed in water and then stored outdoors long enough to lay eggs in the spring when new growth was appearing in the field. The data from these two trials indicated that there was no risk that the adelgids on Nordmann fir would spread via the movement of cut Christmas trees or boughs under our test conditions.

Table 4. Effect of postharvest treatments on the viability of adelgids on cut Nordmann fir branches.

Treatment[1]	Mot.[2]	Eggs	Craw.	Mot.	Eggs	Craw.	Mot.	Eggs	Craw.	Mot.	Eggs	Craw.
2013-14	9-Jan.			19-Feb.			26-Mar.			9-Apr.		
1	+	-	-	+	-	-	+	+	-	+	+	+
2	+	-	-	+	-	+	+	-	-	-	-	-
3	+	+	+	+	+	+	+	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-
2014-15	2-Jan.			15-Feb.			25.Mar.			13-Apr.		
1	+	-	-	+	-	-	+	-	-	+	+	+
2	+	-	-	+	-	-	-	-	-	-	-	-
3	+	-	-	+	-	-	-	-	-	-	-	-
4	+/-	-	-	-	-	-	-	-	-	-	-	-

[1]Treatment 1 = Branch on tree, 2 = branch harvested and stored outdoors, 3 = branch harvested and displayed in water for one month and then stored outdoors, and 4 = branch harvested and displayed dry for one month and then stored outdoors.

[2]Codes: Mot. = stem mother adelgid, Craw. = adelgid crawler, "+" = live life stage present, "-" = life stage absent or dead.

Effectiveness and residual activity of conventional and new insecticides for control of the adelgid.

In 2014, a control trial was set up using trees in the infested 2004 Nordmann and Turkish fir genetic trial at WSU PREC. Five products (Table 5) were applied as foliar sprays, broadcast treatments to the soil, or direct applications to the basal bark on the stems of trees (Table 6). A single tree in each of 7 blocks was treated with each insecticide treatment. Checks consisted of a non-treated tree in each block. All treatment trees were separated from each other by at least 12 feet to prevent any effect from adjacent treatments due to overspray or runoff. Treatments to control the silver fir woolly adelgid generally target the crawler stage, so they were applied in April and trees were evaluated for adelgid damage as indicated in the susceptibility trials above in September. Results indicate that the foliar applications of OnyxPro and Ultor were the only

treatments that significantly reduced the damage caused by the adelgids. Since adelgid treatments often provide more than one year of control, in 2015 we reevaluated the trees that were treated in 2014 to determine if there was any residual activity of the treatments. The data showed that there was no difference between the treatments (Table 7). Although the damage ratings were generally lower in 2015, this would indicate that there was no residual control from the 2014 treatments so growers would need to treat trees every year to control this pest.

Table 5. Products used in adelgid control trial.

Products	% active ingredient	Source
Ultor	14.4% spirotetramat	Bayer
Safari 20SC	20% dintefuran	Valent
OnyxPro	23.4% bifenthrin	FMC
Admire Pro	41.8% imidacloprid	Bayer
Syl-Tac	organosilicone surfactant	Wilbur-Ellis
Preference	NIS surfactant	Winfield

Table 6. Treatments rates, application sites, and application timing.

Treatments[1]	Rate	Type[2]	Timing[3]
Admire Pro + Syl-Tac	4 fl oz/A	Foliar	1
OnyxPro	6 fl oz/A	Foliar	1
Ultor + Preference NIS	16 fl oz/A	Foliar	1 & 2
Admire Pro	12.8 fl oz/A	Broadcast	1
Admire Pro	25.6 fl oz/A	Broadcast	1
Safari 20SG	0.75 lb/A	Basal bark	1
Check	-	-	-

[1]Syl-Tac @ 4 fl.oz. and Preference NIS @ 0.25% v/v
[2]Sprays applied in 47.3 gal/A (foliar) or 11.9 gal/A (broadcast)
[3]Timing: 1 = April 8-11, 2014 and 2 = April 25, 2014

Table 7. Effect of adelgid treatments on 2014 needle curling and damage ratings on Nordmann fir trees[1].

			2014 Data		2015 Residual Control	
Treatments	Application site	Rate/A	Curling	Damage	Curling	Damage
Check	-	-	4.4a[2]	3.0a	1.3a	1.5a
Admire Pro+Syl-Tac	Foliar	4 fl.oz.	4.0ab	3.0a	0.8a	1.0a
Admire Pro	Broadcast	12.8 fl.oz.	4.0ab	3.0a	0.7a	0.7a
Safari	Basal bark	0.75 lb	3.0abc	2.4ab	1.0a	1.1a
Admire Pro	Broadcast	25.6 fl.oz.	2.8abc	2.8a	1.7a	1.6a
Ultor	Foliar	16 fl.oz	2.0bc	1.8bc	2.1a	1.9a
OnyxPro	Foliar	6 fl.oz.	1.4c	1.2c	1.0a	1.3a

[1]Curling was rated on a scale of 0 to 5, with 0 = no curling or evidence of adelgids and 5 = most needles are curled throughout the branch and many of the needles have a yellow or brown color. Overall damage was rated on a scale of 0 to 3, with 0 indicating no damage and 3 indicating an unmarketable tree.
[2]Columns with the same letter are not significantly different, P<0.05, Tukey's Studentized Range (HSD) Test.

Summary

- The silver fir woolly adelgid [*Adelges* (*Dreyfusia*) *nordmannianae*] is a serious pest on Nordmann fir.

- Although rarely seen in the PNW, this adelgid has been sporadically detected on Nordmann fir Christmas tree plantations since 2010. The adelgid population can rapidly increase over a two-year period, as seen at WSU PREC in 2010-2012.
- **Given detections of the adelgid in several Puget Sound area plantations in 2025, growers are encouraged to monitor their fields for this pest.**
- While symptoms caused by the silver fir woolly adelgid are evident year-round, spring is an excellent time to monitor fields to determine if this pest is present and make decisions about controlling it.
- Nordmann and Turkish fir host susceptibility trials found there was considerable genetic variability in susceptibility between seed sources of Nordmann fir, and that limited damage occurred on Turkish fir.
- Over a three-year period, the highest level of damage to multiple fir species occurred on the Nordmann and European silver firs. Given the very limited, if any damage observed on other species, there appears to be low risk of this adelgid attacking most of the common North American *Abies* species grown as Christmas trees in North America.
- One of the most striking findings was the apparent natural collapse of the adelgid population and the limited damage that occurred on in 2016. Additional studies might help to determine if this collapse was due to the buildup of natural predators.
- Results of detached branch testing indicate that there was no risk that adelgids on Nordmann fir would spread via the movement of cut Christmas trees or boughs under our test conditions.
- Life cycle studies indicated there are two generations of this pest in the PNW and that the first generation of crawlers can appear up to 3 to 4 weeks prior to bud break.
- Growers can use Growing Degree Days (GDD) to predict when crawlers will emerge and time pesticide applications. The goal is to protect newly emerging shoots and needles for the crawlers.
- In a limited control trial, foliar applications of OnyxPro and Ultor were the only treatments that significantly reduced the damage caused by the adelgids. There was no residual control from the treatments one year later so growers would need to treat trees every year to control this pest.
- Trials are needed to evaluate the effectiveness of additional "adelgid" insecticides and optimize application timing to enhance the control of the silver fir woolly adelgid.

Please help us understand the extent of Nordmann fir production in the PNW, and the distribution of the silver fir woolly adelgid, click on the QR Code to share with us information about your production of Eurasian (Nordmann, Turkish, and Trojan) firs and the results of your monitoring even if no potential adelgid damage was detected.

Acknowledgements

- Portions of this research described in this document were supported by the WSDA Specialty Crop Block Grant program, PNWCTA Advanced Research program, and the WSDA Christmas Tree License Research program.
- Collaborators included Dr. Art Antonelli (WSU), Dr. Ulrik Brauner Nielsen (University of Copenhagen), Chal Landgren (OSU), Dr. Richard Cowles (CTAgES), and Dr. Nathan Havill (USDA Forest Service).
- The assistance of industry stakeholders who donated seedlings and assisted in culturing trees in research plots at Puyallup is greatly appreciated.