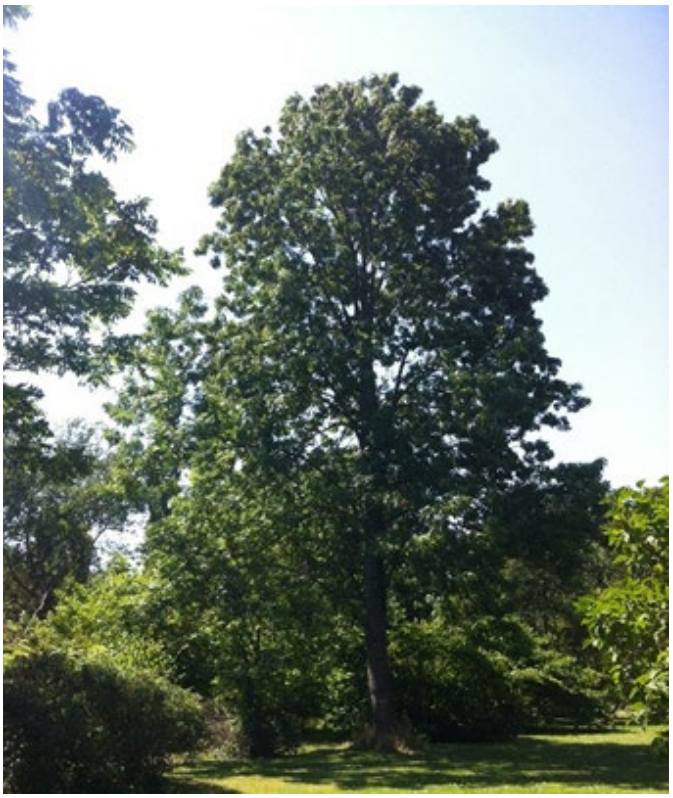
Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

SLU Partnerskap Alnarp

SLUTREDOVISNING 2022-XXXX



A resistant ash tree and ideal candidate for the future population of ash, showing little evidence of crown dieback.

Rädda Asken:- identifiering av resistenta askträd i sydsvenska bestånd

SLU Partnerskap Alnarps projekt nr: 1411

Projekttitel på svenska enligt projektansökan: Rädda Asken:- identifiering av resistenta askträd i sydsvenska bestånd

Projekttitel på engelska enligt projektansökan: Saving European ash - selection of resistant ash trees in southern Swedish stands

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Projekttid: 2206-2212.

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Projektsammanfattning

Askdöd, orsakad av den invasiva svampen *Hymenoscyphus fraxineus*, hotar överlevnaden för vanlig ask (*Fraxinus exclesior*) i större delen av Europa. Studier tyder på att det finns en stark genetisk, ärftlig komponent i värdpopulationen för resistens mot sjukdomen, och att asken som trädart kan ”räddas” genom urval och förädling. Sedan 2013 har det gjorts ett genetiskt urval från resistenta askträd i hela Sverige som varit lyckosamt. Dessa träd visar lite eller inga tecken på utbredd sjukdom i områden med högt infektionstryck.

Under de senaste åren har en stor databas med flera hundra resistenta genotyper tagits fram men få har spridits och testats. Detta projekt ska inventera och kontrollera status för tidigare planterade träd i fält för att sedan använda dessa för urval i vilka genotyper som ska prioriteras för vidare förädling. Projektet är en del i ett större arbete att säkerställa en framtid för ask i skog och stadslandskap, med fokus på de Sydsvenska bestånden. Läs mer på www.raddaasken.nu

Abstract

Ash dieback, caused by the alien invasive fungus Hymenoscyphus fraxineus, is currently threatening the survival of common ash (Fraxinus exclesior) throughout most of Europe. Studies from Sweden and other countries suggest a strong genetic, heritable component in the host population for resistance against the disease, and that considerable gain can be achieved through selection and breeding. Since 2013, several small steps have been taken in the effort to “save the ash” through careful selection of vital (resistant) ash from across the whole range of the distribution area in Sweden. These trees characteristically show little to no evidence of dieback in areas that are heavily diseased (i.e. exposed to similar infection pressure). We have been slowly building up a large inventory database of several hundred resistant genotypes but only a subset of those have been propagated and tested. We aim to test a much higher number of genotypes (~1000) considering the importance of having a high level of genetic diversity in the bred population, and the likelihood that the pathogen may change genetically overtime affecting its overall virulence and resulting damage on the host. New financing during 2022 (from Werners fond to Skogforsk) allows us to revisit inventories from 2015 and 2019 where trees were previously marked for selection. Building on our previous efforts, we now (under this new application to Partnerskap Alnarp) plan to reinventory and check the status of the trees marked for selection in order to prioritize genotypes for the next step: scion collection and clonal propagation and testing. The project is critically important in continuing to build towards our goal of saving this important noble broadleaved tree species, ensuring a future for ash in forests and urban landscapes, and the biodiversity that relies on ash which, because of the loss of ash, is largely threatened today.

Bakgrund

Ash dieback, caused by the alien invasive fungus *Hymenoscyphus fraxineus*, is currently threatening the survival of common ash (*Fraxinus exclesior*) throughout most of Europe. Starting in the early 1990s, large-scale decline of common ash was reported from Poland and Lithuania (Juodvalkis and Vasiliauskas 2002; Przybył 2002). In Sweden, the disease was first noticed in 2001 but by 2005 it was widespread throughout the natural distribution range in the country. Though the exact origin of *H. fraxineus* is still unknown, evidence suggests the same fungus

occurs in Japan, China, Korea, and Far East Russia (Zhao et al. 2013; Zheng and Zhuang 2014; Han et al. 2014; Cleary et al. 2016), and that most likely it was inadvertently introduced into the Baltic countries in the late-1980s on nursery stock of Asian *Fraxinus* species (Woodward and Boa 2013).

As with most introduced pests and pathogens where the host plant lacks a history of co-evolution, the damage is devastating. The situation is now critical in Sweden and elsewhere across Europe as large populations of ash are disappearing from our forests and the urban landscape (Figure 1). In 2010, ash was put on the Swedish Red-List but by 2015, its status worsened to be 'critically endangered' considered to be at risk of extinction in the wild. This is concerning not only for the loss of this important noble broadleaved tree species, but also for the biodiversity of species dependent on ash that are indirectly affected by the disease. In Sweden, it has been estimated that there are 483 species dependent on ash, 123 of which are threatened (Hultberg et al. 2020). Several of these species are already red-listed and a large proportion are either obligately- or highly associated to ash which means further loss of ash will, if it hasn't already, instigate an extinction cascade.

Figure 1. On right, the fungus *Hymenoscyphus fraxineus* infects the leaves and then woody shoots of trees annually. On left, a stand of European ash at a nature reserve in Säffle in 2014. Trees have either died or are moribund with severe dieback of the crown. Photo credit: Michelle Cleary

Currently, there are no effective means to control the spread of ash dieback and the majority of trees in all age classes appear to be affected. The most promising outlook to ensure that ash has a future in forests, cities and landscapes is to find resistant individuals and cultivate more resistant ash genotypes for planting. Some evidence of natural resistance has been observed even in heavily damaged ash stands whereby some trees appear quite healthy, displaying very few bark cankers and dieback symptoms. In Denmark, susceptibility was found to be under strong genetic control and genotypic variation was substantial in two seed orchards (McKinney et al. 2011). In a progeny trial in Lithuania, ten Lithuanian and 14 other European populations of ash showed high heritability in tolerance to *H. fraxineus* infection (Pliura et al. 2011). Here in Sweden, surveys of 106 plus-tree ash clones in seed orchards indicated strong genotypic variation in their level of susceptibility to *H. fraxineus* (Stener 2007). Though no individual appears to be fully resistant, some individuals show dramatically lower susceptibility to the disease and continue to express this resistance after several years of heavy infection pressure (Stener 2013) (Figure 2). This genetic variation in the ash population demonstrated by these studies appears

to be substantial enough to suggest considerable gain through selection and long-term breeding.

Figure 2. Susceptible and tolerant European ash genotypes at a seed orchard trial located in Snogeholm. Photo credit: Michelle Cleary

Since 2013, concerted efforts have been made through the project "Save the Ash" (Rädda Asken) to develop a resistant population of ash in Sweden. Initial work between 2013-2015 generated a large inventory of more than 500 putatively resistant genotypes (showing high levels of natural resistance to the pathogen) across the whole range of the distribution area in Sweden (Figure 3).

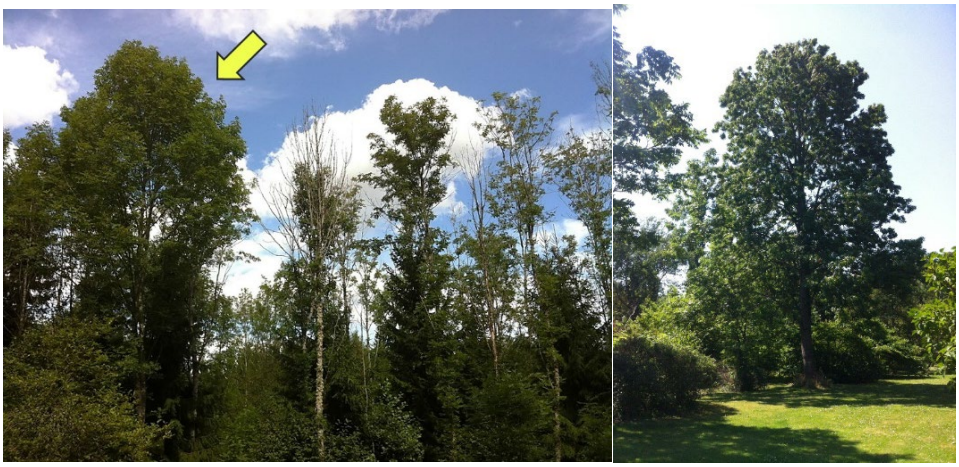

Figure 3. Selection of putatively resistant ash from key habitat (nykelbiotop) areas and landscapes heavily affected by ash dieback disease in the southern half of Sweden. Selection of 'resistant' trees is based on trees that characteristically show very little evidence of crown or shoot dieback, minimal stem and/or branch necrosis, and minimal evidence of adventitious shooting (which is a typical stress response to the disease), such that 80% or more of the trees' crown is intact compared to other heavily diseased neighbouring trees.

Syfte

The goal is to improve the growing material of ash in Sweden with a focus on resistance to the pathogen (*Hymenoscyphus fraxineus*) causing ash dieback disease, and at the same time, archive ash with high resilience for gene conservation. This is done by re-inventorying the vital ash trees that were selected in 2019 from tips obtained from the public and from several trees that were identified as resistant in earlier surveys from 2015. There should be about four growth seasons since the trees were initially inventoried. The goal is to record the trees' resistance status to the pathogen.

Metod

In order to build up a population of resistant ash trees, first a selection of ash trees that looked vital was made in 2015 based on tips from the public and various forestry organisations. During the summer of 2018, the trees were revisited with the aim of checking health status. A total of 400 of the original 508 boxes were recovered, of which 227 were assessed to be undamaged and have good stem quality. The second selection took place in the summer of 2019 with the help of funds from the Association of Forest Tree Breeding whereby a further 400 ash trees were selected. During the summer of 2020, an additional selection took place and approx. 250 vital boxes were selected with the help of funds from Stiftelsen Stina Werner's fund. During the summer (August, early September) 2022, we checked the health status of the 400 ash trees that were identified in 2019. Based on the results, we should be able to plan the collection of inoculum for new clone tests to be carried out in the following years.

Resultat och Diskussion

The new inventory has allowed us to refine the status of our resistant inventory database which will increase the efficiency when it comes to selection and testing of genotypes in screening trials – which is still something that must be done on a large scale pending sufficient financing. This work is a critical first step to enable targeted genotypes to be selected for further commercial propagation, breeding and possible future establishment of new seed orchards. In order to support the development of a more resistant ash population for planting in Swedish forests, cities and landscapes, we need continued support for an operational tree improvement program at Skogfork to ensure a future for this important noble broadleaved tree species. For more information, visit our website “Save the Ash” www.raddaasken.nu

Referenser

Cleary M, Nguyen D, Marčiulynienė D, Berlin A, Vasaitis R, Stenlid J. 2015. Friend or foe? Biological and ecological traits of the European ash dieback pathogen *Hymenoscyphus fraxineus* in its native environment. Scientific Reports 6, 21895; doi:10-1038/srep21895 (2016)

Han, J-G., Shrestha, B., Hosoya, T., Lee, K-H., Sung, G-H., & Shin, H-D. 2014. First report of the ash dieback pathogen *Hymensocyphus fraxineus* in Korea. *Mycobiol*. **42**:391-396

Hultberg, T., Sandström, J., Felton, A., Öhman, K., Rönnberg, J., Witzell, J., & Cleary, M. (2020). Ash dieback risks an extinction cascade. Biological Conservation, 244. https://doi.org/10.1016/j.biocon.2020.108516

Juodvalkis A., Vasiliauskas A., The extent and possible causes of dieback of ash stands in Lithuania. LŽŪU Mokslo Darbai, Biomedicinos Mokslai. **56**:17-22 (2013). (In Lithuanian with English summary.)

McKinney, L.V., Nielsen, L.R., Hansen, J.K., Kjær, E.D. Presence of natural genetic resistance in *Fraxinus excelsior* (Oleaceae) to *Chalara fraxinea* (Ascomycota): an emerging infectious disease. Heredity, **106**: 788–797 (2011)

Pliura A, Lygis V, Suchockas Y, Bartevicius E. Performance of twenty four European *Fraxinus excelsior* populations in three Lithuanian progeny trials with a special emphasis on resistance to *Chalara fraxinea.* Balt For. **17**:17–33. (2011)

Przybył K., Fungi associated with necrotic apical parts of *Fraxinus excelsior* shoots. For. Pathol, 2002. **32**:387-394

Stener L-G., Studie av klonskillnader i känslighet för askskottsjuka. *In:* Arbetsrapport från Skogforsk nr 648, 2007.14 pp (2007)

Stener L-G., 2013. Study of clonal differences in susceptibility to the dieback of *Fraxinus excelsior* L. in southern Sweden. Scandinavian Journal of Forest Research. Scand J For Res. **28:** p. 205-216

Woodward S, Boa E. 2013. Ash dieback in the UK: a wake-up call. Mol Plant Pathol **14**:856-60

Zhao, Y–J., Hosoya, T., & Baral, H-O., Hosaka, K., & Kakishima, M. *Hymenoscyphus pseudoalbidus*, the correct name for *Lambertella albida* reported from Japan. *MycoTaxon* **122**:25-41 (2013)

Zheng, H-D., Zhuang, W-Y. *Hymenoscyphus albidoides* sp. nov. and *H. pseudoalbidus* from China. *Mycol. Progress*. doi, 10.1007/s11557-013-0945-z (2014)