



Genetic characterisation of Sitka spruce in Ireland

TEAGASC research investigates whether information from DNA can be used to support the Irish Sitka Spruce Tree Improvement Programme.

The global forest resource is increasingly becoming challenged by the effects of climate change. In Ireland, new diseases in ash and larch trees have posed great challenges to our forests. However, significant potential exists to utilise tree-breeding strategies to select trees that may be more adapted to future climates or have more resilient characteristics. Significant advancements in genomics have taken place in recent years and these are being used to provide a better understanding of the differences in the genetic makeup of populations of trees and have widespread applications to assist tree-breeding efforts. A new project called GenESIS featuring researchers from Teagasc, UCD, Trinity College Dublin, NUI Galway and the National Botanic Gardens, hopes to document the genetics of Sitka spruce forests in Ireland. The proposed research involves the development of a new genotyping platform that will be utilised for assessing genetic diversity, DNA fingerprinting, and if genomic

selection can be used to accelerate tree-breeding efforts. Tree breeding aims to select the best trees to use as parents to produce the next generation. Desirable traits include faster growth rates, straightness, and increased wood properties, all of which offer the potential to increase productivity, carbon sequestration, and ultimately the most efficient use of wood-based products. The objectives of a tree-breeding programme can range from yield improvement and adaptation to particular conditions, pest resistance, improvement of wood characteristics, etc. More recently, tree-breeding efforts have focused on selecting populations or individuals that may be more adapted to future climates.

Special characteristics

As certain populations of trees may have evolved under increased disease pressure or in isolated areas, they may have genes that

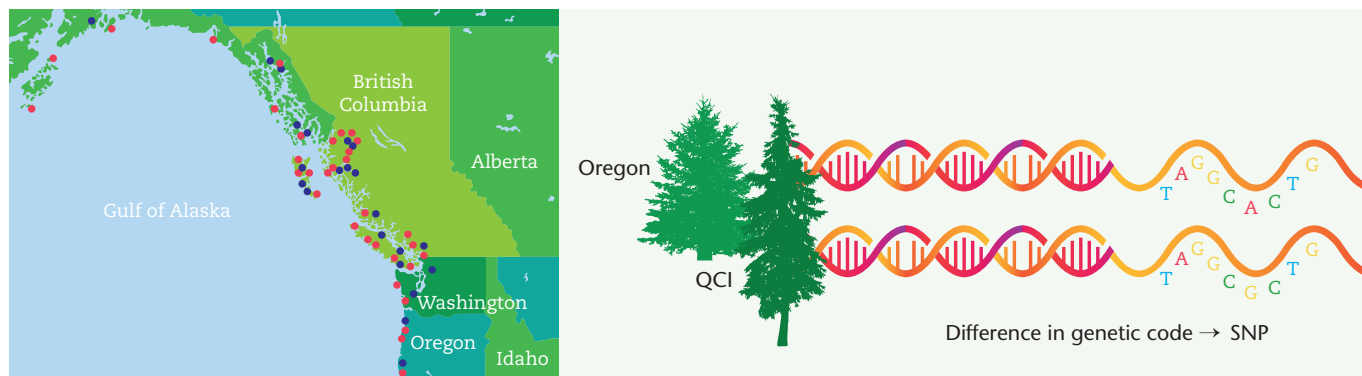


FIGURE 1: Sitka spruce has a geographic distribution covering 3,000 km. Certain populations may display genetic differences, which may contain valuable traits that can be used to breed trees that are taller, stiffer, straighter, more resistant to insect pests and more adapted to future climates.

control the production of metabolites, which affords them increased protection from insect pests and diseases, or conveys increased tolerance to drought events. Sitka spruce is a species that has a wide range of over 3,000 km and occurs from Alaska to California. It is an ideal study species as it has evolved over a wide latitudinal gradient, with some populations isolated by physical geography; these populations may differ in their genetic makeup and may contain these valuable traits (Figure 1).

The first step is to assess the genetic diversity of Sitka spruce, and the GenESIS team has taken cambium samples for DNA isolation from the JFK conservation collection representing Sitka spruce's indigenous range. Thereafter, an assessment of the variability in DNA among trees will be carried out to determine if trees from different geographic regions differ in their genetic composition. This information can ultimately be used for genetic fingerprinting, where a tree of unknown origin can be associated to a particular region based on its DNA profile.

This will provide a template in which to assess the levels of genetic diversity in the Irish Sitka Spruce Tree Improvement Programme, currently operated by Coillte. This programme has been in operation since the late 1970s and is comprised of trees selected for favourable height growth and timber density; however, to date these have undergone limited genetic characterisation.

Genomic selection

There is increasing interest in using genomic selection (GS) in tree breeding to select faster-growing trees with desirable timber properties at a very early age, speeding up the process of tree improvement. GS offers the potential to accelerate the selection of improved progeny using DNA markers, and without having to wait for the traits to manifest. Genetic characterisation is intended to not only examine traits related to timber production but also the possibility of either expanding resistance to pests and climate tolerance traits, or whether it is necessary to introduce these traits into the Improvement Programme from external sources. Genetic characterisation of Irish Sitka spruce would therefore help to ensure continued improvement of the

Irish Sitka spruce population and inform crossing decisions to recombine trees to produce the next generation of elite trees. The GenESIS project will lay the groundwork to enable GS to be utilised in tree breeding in Ireland. Genotyping will also be deployed to assess the efficiency of current seed orchards and help to design the next generation of seed orchards to support timber production in Ireland.

Given the Government ambition of planting 440 million trees, equivalent to 8,000 hectares per annum, in the next 20 years, the sustainable use of genetic resources is critical to the achievement of this objective. As many forests in Ireland contain Sitka spruce, these forests are a critical reservoir of carbon (stored in biomass and soils) and an important source of renewable raw material for the circular bioeconomy. It is important that the next generation of trees is suitably adapted to fulfil these functions, and that future forests are suitably resilient so that their maximum benefit to society can be realised.

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