Fraxinus excelsior L.

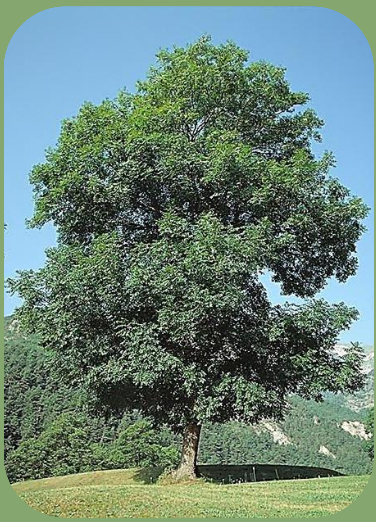
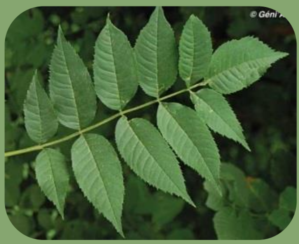


Photo: Giuseppe Mazza

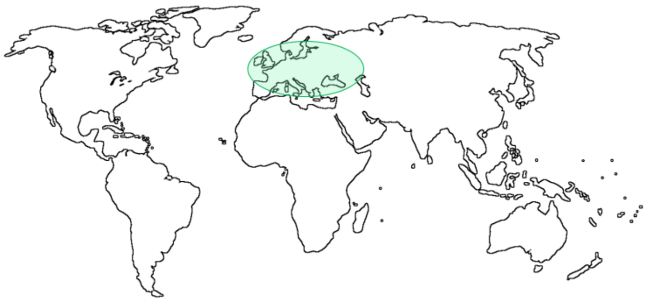


Source: ouvrage.geni-alp.org

Source: rhs.org.uk

Origin and diffusion

Origin: Europe and Caucasus
Distribution: It is naturally found in Europe, Asia Minor and North Africa.
Invasive potential: low



Introduction

Tall and graceful deciduous tree, reaching an age of 300 years and heights of 40m; it can grow also as a shrub in exposed conditions. Trees often grow together, forming a light domed canopy casting a relatively light shade which allows a variety of other plants to grow beneath them; there is therefore often a rich shrub and field layer in Ash woodlands. For this reason those trees are important for the functioning and conservation of forest ecosystems throughout much of Europe. It is a flexible species which can be found over a range of growing conditions, from riparian to mountain and steep slope stands, from pioneer to mature and old-growth woodland, from nutrient-rich to poorer soils.

The wood is hard, elastic and used for woodworking, valuable as firewood. It is a sporadic and demanding tree, that grows on deep, cool and moist soil. The water represents a limiting factory for the tree, because it consumes it a lot for its speed of growth and evapotranspiration. It can easily be damaged by drought because retards to control transpiration by closing stomata, however, can withstand even a month of submersion of the roots.

Common ash has long played important socio-cultural roles, for example, according to Norse mythology, Yggdrasil is the great ash tree holding the universe together with its mighty roots and branches.

Common names: Common Ash, European Ash (English), Frassino maggiore, Frassino comune (Italian)

Fam. *Oleaceae*

Description

Life-form and periodicity: deciduous tree; often grows as shrub in exposed conditions.

Height: 18-40 m

Roots habit: the tap root become indistinguishable from the larger lateral roots after the first year. The root system is well developed and can go deep, giving the plant a remarkable stability.

Probable rooting depth range for mature trees:

in soils with moisture retaining upper horizons, soils with wet lower horizons and well drained organic rich soils: < 1,5

in loose, deep well-drained soils and in intermediate loamy soils: < 2 m

Culm/Stem/Trunk: diameter of the trunk up to 2 m, straight and slender.

Bark: The bark is smooth and pale grey in young trees, becoming thick and vertically fissured in mature trees.

Crown: oval-pyramidal in youth, more rounded with age.

Leaf: pinnate leaves, comprising 6-12 opposite pairs of light green, oval leaflets with long tips, up to 40cm long, with a serrated margin. Leaves fall when they are still green.

Rate of transpiration: 800-3200 L/day/tree

Reproductive structure: Ash is typically dioecious, although a single tree can also have male and female flowers on different branches. Both male and female flowers are purple and appear before the leaves in spring. The flowers are grouped in small clusters shaped like a panicle. A tree that is all male one year can produce female flowers the next and vice versa.

Propagative structure: conspicuous winged fruits (samaras), containing only one seed and often hanging in bunches. Seed is viable for 2–3 years. The seeds remain dormant for one vegetation period (sometimes for two or more) before germinating.

Development

Sexual propagation: The pollination is anemophilous. Seeds are mainly dispersed by the wind, but can also disperse along watercourses and survive in water for several weeks.

Development

Asexual propagation: It does not reproduce vegetatively

Growth rate: rapid

Habitat characteristics

Light requirement: shade tolerant as a sapling, but light demanding as a mature tree.

Soil requirements: It prefers fertile, moist but well-drained soils, underlain calcareous rocks, notably chalk, oolite and limestone. pH range of 5 to 8.

Tolerance/sensitivity: avoidance of nutrient-poor soils and acidic soils with pH<4. Intolerant to frost during first stage of growth and during bud development. .

Phytotechnologies applications

This plant has been used in vegetative covers on **heavy metal** polluted sites, helping to avoid dispersion of contaminants through wind erosion and by reducing the volume of water percolating through the soil. This species is considered an heavy metals excluder, useful in phytostabilisation of polluted soil or sediments; ash trees may have a mechanism to avoid metal uptake by stabilizing it in the rhizosphere or exclude it from their above-ground tissues by keeping in their roots (Rosselli et al., 2003). In this way *Fraxinus* reduces the risk of metal dispersal and is therefore suitable species for phytostabilisation (Mertens et al., 2004).

Additionally, F. excelsior is pioneer plant known to be able to adapt and survive in harsh environments and, thus, is interesting in rehabilitating contaminated soils that have also extreme chemical and physical characteristics (Rosselli et al., 2003).

A study showed that the sharp decrease in **trichloroetylene (TCE)** concentration of contaminated groundwater plume under a common ash planted area, was related to trees evapotranspiration activity leading to evaporation of a significant amount of TCE and its metabolites through the leaves to the atmosphere (Weyens et al., 2009).

Phytotechnologies applications

Experimental studies

-Experiment 1-

Reference	Mertens, J., Vervaeke, P., De Schrijver, A., & Luyssaert, S. (2004). Metal uptake by young trees from dredged brackish sediment: limitations and possibilities for phytoextraction and phytostabilisation. Science of the total Environment, 326(1), 209-215.
Contaminants of concern	Cd, Pb, Zn and Na
Mechanism involved in phytoremediation: Phytostabilisation/rhizodegradation/phytoaccumulation/phytodegradation/phytovolatilization/ hydraulic control/ tolerant	Phytostabilisation
Types of microorganisms associated with the plant	Not reported in the publication
Requirements for phytoremediation (specific nutrients, addition of oxygen)	Any requirements
Substrate characteristics	The trees were planted on a mound constructed of dredged sediment. The dredged sediment had a high pH and a high nutrient stock, high electrical conductivity and high Na concentrations.
Laboratory/field experiment	Field experiment
Age of plant at 1st exposure (seed, post-germination, mature)	2 years old seedlings
Length of experiment	2 years
Initial contaminant concentration of the substrate	According to reference data for heavy metals (Kabata-Pendias and Pendias, 1992), Cu concentrations (53.9-54.2mg kg^{-1} DW) were in the normal range, Pb (74.3-75.2 mg kg^{-1} DW) and Zn (358-359 mg kg^{-1} DW) concentrations were relatively high, and Cd concentrations (5.7-5.9 mg kg^{-1} DW) were more than three-fold higher than the upper range.
Post-experiment contaminant concentration of the substrate	Not reported in the publication

Phytotechnologies applications

Post-experiment plant condition	Despite high sodium concentrations in the sediment, mortality of the planted seedlings was limited to 2% two years after planting. The trees showed stunted growth (2 cm, after the second growing season). On almost 80% of the ash trees necrosis of the leaf margins was observed, a typical symptom of salt stress.
Contaminant storage sites in the plant and contaminant concentrations in tissues (root, shoot, leaves, no storage)	No storage Ash trees, two years after planting, contained normal concentrations of heavy metals in them foliage (according to different literature references). Foliar heavy metal concentration (mg/Kg DW, mean± standard deviation, n=6): Cd-0,3±0,3, Cu-12,4±1,8, Pb-5,0±1,2, Zn-26± 8.

-Experiment 2-

Reference	Rosselli, W., Keller, C., & Boschi, K. (2003). Phytoextraction capacity of trees growing on a metal contaminated soil. Plant and soil, 256(2), 265-272.
Contaminants of concern	Cu, Zn and Cd
Mechanism involved in phytoremediation: Phytostabilisation/rhizodegradation/phytoaccumulation/phytodegradation/phytovolatilization/ hydraulic control/ tolerant	Phytostabilisation
Types of microorganisms associated with the plant	Not reported in the publication
Requirements for phytoremediation (specific nutrients, addition of oxygen)	Not reported in the publication
Laboratory/field experiment	Field experiment

Phytotechnologies application

Substrate characteristics	Contaminated compost originating from sewage sludge and uncontaminated added to earth and gravel. Organic carbon 56±1 mg kg-1; pHcacl2 7,4±0,1; clay 430±130 mg kg-1; sand 300±120 mg kg-1. Soil layer depth: 1.0–1.2 m
Length of experiment	13 years
Age of plant at 1st exposure (seed, post-germination, mature)	Germinated seed
Initial contaminant concentration of the substrate	Not reported
Post-experiment contaminant concentration of the substrate	3 years after planting, concentrations (mg kg-1) of copper, zinc and cadmium in the contaminated area were 557 ± 51, 620 ± 41 and 1.8 ± 0.20, respectively. These are slightly higher compared to the Swiss guideline values (40, 150 and 0,80 mg kg-1, respectively)
Post-experiment plant condition	Common ash established successfully on the heavy metal-polluted soil.
Contaminant storage sites in the plant and contaminant concentrations in tissues (root, shoot, leaves, no storage)	This plant species may have a mechanism to avoid metal uptake by stabilising it in the rhizosphere or exclude it from their above-ground tissues by keeping it in their roots Root analyses could not be performed after the experiment.