Medicago sativa L.

Source : missouriplants.com

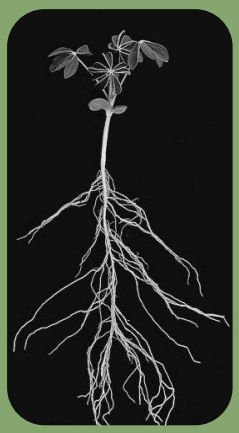

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Photo : M. Zepigi

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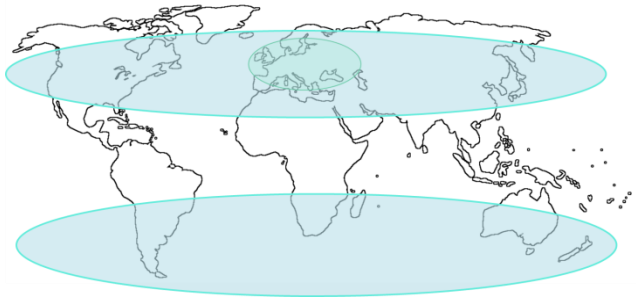
Origin and diffusion

Origin: south western Asia (Persia)
Distribution: widely distributed temperate zones of the world
Invasive potential: low



Introduction

Alfalfa is a yellow flowering plant, with trifoliate leaves. It is an important forage crop, widely distributed in temperate zones of the world. This cool season perennial legume can live from three to twelve years, depending on variety and climate. Like other legumes, its root nodules contain a bacteria, *Sinorhizobium meliloti*, with the ability to fix nitrogen, producing a high-protein feed regardless of available nitrogen in the soil and increasing the soil nitrogen content. Alfalfa can be used as an important break crop in the rotation; it has a wide range of adaptation, if not properly managed it may become weedy or invasive in some regions or habitats.

Common names: Alfalfa, Lucerne (English); Erba Medica (Italian)

Description

Life-form and periodicity: perennial herb

Height: 30-100 cm

Fam. *Fabaceae*

Description

Roots habit: The plant has a taproot which may penetrate deep into the soil, sometimes stretching more than 6 m. Upon germination, a strong taproot develops rapidly and penetrates almost vertically downward. It often reaches a depth of 150-180 cm the first season, 3-4 m by the end of the second year, and may ultimately extend to depths of 6 m or more. However, typically 60-70 percent of the root system is concentrated in the upper 15 cm of soil, with fibrous roots predominating and bearing most of the nodules. Like other legumes, its root nodules contain bacteria, with the ability to fix nitrogen. To stimulate root growth, the young stand should be irrigated frequently because root development is adversely affected by dryness.

Culm/Stem/Trunk: stem erect, hollow, moderately strong

Leaf: : alternately arranged on the stem and normally trifoliate. The margin is denticulate.

Rate of transpiration: 1,7 – 10,5 mm/day

Reproductive structure: the flowers are grouped in racemes to axil of the leaf and can vary in colour from purple to yellow.

Propagative structure: the fruit is a legume, spiral shaped with 2-6 seeds.

Development

Sexual propagation: the seed production requires the presence of pollinators, bees in particular.

Asexual propagation: some genotype of alfalfa has a form of vegetative propagation (creeping-rootedness) consisting on the development of new plants from adventitious shoots arising from roots with horizontal growth habit

Growth rate: fast

Habitat characteristics

Light and water requirements: Full sun. Crop water requirements are between 800 and 1600 mm/growing period depending on genotype, climate and length of growing period. To stimulate root growth, the young stand should be irrigated frequently because root development is adversely affected by dryness.

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Habitat characteristics

Soil requirements: it adapts to a wide variety of soils-with deep, medium textured and well-drained soils being preferred. It requires pH 6,5 or above. Lands subject to frequent overflows or high water tables are unfavourable.

Tolerance/sensitivity: the deep taproots allows it to be highly tolerant to drought. The crop is moderately sensitive to soil salinity, and sensitive to flooding and shade.The optimum temperature for growth is about 25°C and growth decreases sharply when temperatures are above 30°C and below 0°C.

Phytotechnologies applications

Alfalfa is fast-growing, with an active deep rooted rhizosphere and high biomass producing plant, used for phytoremediation (uptake) of **toxic metals**. Several studies reported that low concentration of metals, ranging from 5 to 10 ppm doses, even stimulated the root and shoot length and to increased biomass of the alfalfa plants (Grifferty *et al.,* 2000; Peralta *et al.,* 2001; Jadia *et al*., 2008).

Furthermore, its extensive root system can enhance the activity of degrading bacteria, promoting the bio-degradation rate of several **organic contaminants** such as polychlorinated biphenyls (**PCBs**), polycyclic aromatic hydrocarbon (**PAH**) and trinitrotoluene (**TNT**), especially in soils with low organic matter content, where those contaminants are less strongly adsorbed to the substrate (Chekol *et al*., 2001; Fan *et al*., 2008; Sun *et al*., 2011)

Experimental studies

-Experiment 1-

Reference	G. Adam and H.J. Duncan, 1999. Effect of diesel fuel on growth of selected plant species. Env. Geochemistry and Health 21: 353–357
Contaminants of concern	Diesel oil, a complex mixture of hydrocarbons
Mechanism involved in phytoremediation: Phytostabilisation/rhizodegradation/phytoaccumulation/phytodegradation/phytovolatilization/ hydraulic control/ tolerant	Rhizodegradation

Phytotechnologies applications

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
Substrate characteristics	Not reported in the publication
Laboratory/field experiment	Not reported in the publication
Age of plant at 1st exposure (seed, post-germination, mature)	Seed
Length of experiment	The germination rates were measured 14 days after planting
Initial contaminant concentration	Plant were exposed to varying concentration of diesel oil: 0 g/Kg, 25 g/Kg, 50 g/Kg
Post-experiment contaminant concentration of the substrate	Not reported in the publication
Post-experiment plant condition	Germination rates of plants exposed to 0, 25 and 50 g/kg of diesel oil were 74%, 84%, 66%, respectively. The overall heights of plants grown in diesel oil contaminated soil were stunted compared to control plants grown in uncontaminated soil. Plants grown in diesel oil contaminated soil exhibit formation of adventitious roots (root structures which arise in unusual positions) plant roots avoid diesel oil contaminated areas completely if they have uncontaminated soil to grow into. If there is no available uncontaminated soil, roots will grow through contaminated regions until they find an area of uncontaminated soil.
Contaminant storage sites in the plant and contaminant concentrations in tissues (root, shoot, leaves, no storage)	No storage

-Experiment 2-

Reference	Peralta, J. R., Gardea-Torresdey, J. L., Tiemann, K. J., Gomez, E., Arteaga, S., Rascon, E., & Parsons, J. G. (2001). Uptake and effects of five heavy metals on seed germination and plant growth in alfalfa (Medicago sativa L.). Bulletin of Environmental Contamination and toxicology, 66(6), 727-734.
Contaminants of concern	Cd, Cr, Cu, Ni and Zn

Phytotechnologies applications

Plant species	*M. sativa*, cultivar Malone
Mechanism involved in phytoremediation: Phytostabilisation/rhizodegradation/phytoaccumulation/phytodegradation/phytovolatilization/ hydraulic control/ tolerant	Phytoaccumulation
Types of microorganisms associated with the plant	Not reported in the publication
Requirements for phytoremediation (specific nutrients, addition of oxygen)	Any requirements reported in the publication
Laboratory/field experiment	Laboratory experiment
Substrate characteristics	Agar-based media
Length of experiment	2 weeks
Age of plant at 1st exposure (seed, post-germination, mature)	seed
Initial contaminant concentration	The concentration of each heavy metal were 0,5, 10, 20 and 40 ppm.

Phytotechnologies application

Post-experiment plant condition	Seed germination The 10 ppm of Cd and Cr and 20 ppm of Cu and Ni, significantly reduced the seed germination. At concentration of 40 ppm, Cd and Cr reduced the seed germination by 50% and seed which germinated died after second week. Root length The root of the plant exposed to 5 ppm of Cd, Cr, Cu, Ni and Zn grew more than the root of the control treatment by 22%, 166%, 156%, 63% and 105%, respectively. The 10 ppm concentration of Cr, Cu and Ni still increased the root size over the control root elongation. A inhibition of root growth at 20 and 40 ppm was observed in the treatments using Cr, Cu and Ni. All Zn concentrations increased the root length by more than 100%of the control. Shoot elongation Exposure to 5 ppm of Cd reduced the shoot elongation by 17% compared with the control. A dose of 5 ppm of Cr, Cu, Ni and Zn increased the shoot length by 14%, 60%, 36% and 7,7%, respectively. Cd and Cr at 10 ppm significantly reduced the shoot elongation. When the concentration of these two metals increased to 40 ppm, the shoot size diminished by 80% and 76%, respectively. The detrimental effects of Cu and Ni were significant at the dose of 40 ppm, causing an elongation reduction of 76% and 58%, respectively. Zn showed a positive effect in shoot size even at 40 ppm.
Contaminant storage sites in the plant and contaminant concentrations in tissues (root, shoot, leaves, no storage)	In general, the metal concentration in the plants increased with the dose of the metal in the media. Metal uptake in shoots: 589-4145 mgCd/Kg, 438-1476 mgCr/Kg, 498-4791 mgCu/Kg, 267-2755 mgNi/Kg, 740-4036 mgZn/Kg. The heavy metals were untaken in the following order: Zn>Cu>Cd>Ni>Cr. The ratio of the amount of metal in shoot to the amount in root for Cd and Cu was about 62%; for Ni, Cr and for Zn, it was 53%, 43% and 18%, respectively.