

Autecology of the **COMMON WALNUT**

Juglans regia L.

Fr. : Noyer commun
Sp. : Nogal Común; Cat.: Noguer comu

Ger. : Echte Walnuss
It. : Noce bianco



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GEOGRAPHICAL DISTRIBUTION

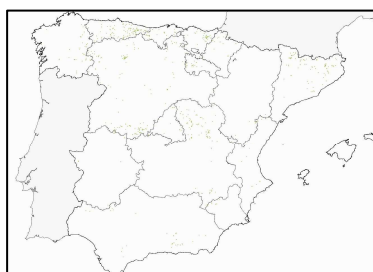
- Species originated in the Balkans [30]; Asia Minor [2] and Persia [10].
- Occurs naturally south of the Caspian Sea and in the southern Caucasus, and extends to Turkey, Bulgaria, Greece, Yugoslavia [22] and as far as China [9, 24].
- **Introduced into Europe in classical times** [30].

Area of origin of the Common walnut in Europe

(Krussmann, 1979, as amended [5])

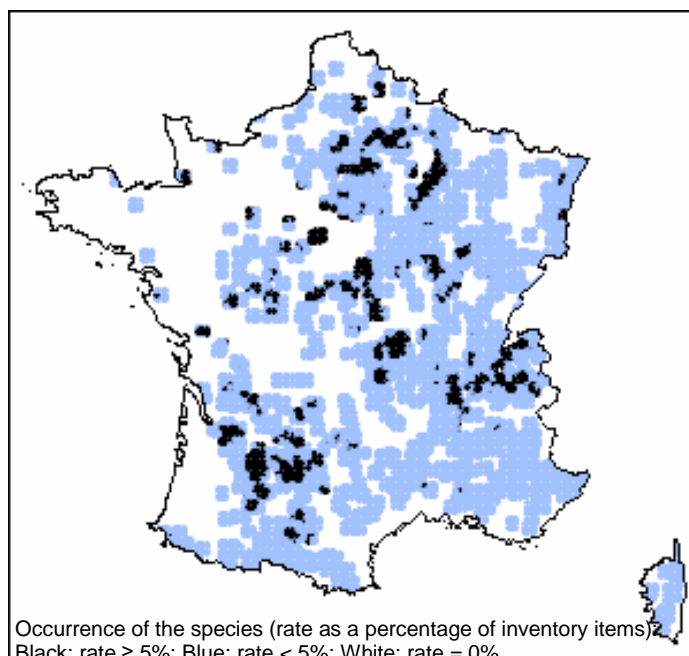


Distribution of the Common walnut in Spain



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Distribution of the Common walnut in France



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Statistics for France:

- Area planted with Common walnut = 20 117 ha (Agreste, 2007).
- Volume of Common walnut in production forests as surveyed in 1996 (NFI): 423,153 m³ (2 021 300 trees). Together with trees surveyed in other woodlands, planted rows, hedges, etc., and single trees, and in the dual-purpose walnut groves in Isère (119,000 m³), the total number of trees amounts to 4.5 - 5 million [7].
- Volume of marketed timber: 100,000 m³/year at the beginning of the last century; 20,000 m³/year in the early 1990s [7].

CLIMATE AND TEMPERAMENT

Bioclimatic conditions

Climate is the main growth factor [5] for this species although it tolerates varied climate conditions [17].

Common Walnut:

- **Prefers mild climates** [30] with dry continental air [17]. Cool and humid climates encourage fungal diseases [5].
- Requires **warmth during the growing season** (6 months with an average temperature ≥ 10 °C) [12, 2, 7, 25, 10, 17, 20].
- **Withstands cold conditions** down to -30 °C in winter if the temperature drops gradually [7, 25]. A sharp drop in temperature can damage or kill the trees [7].
- **Fairly vulnerable to late frost** (for varieties in which the buds break early) and **vulnerable to early frost** (below -7 °C [7, 10] or even -2 °C), especially after a mild autumn and in particular during the first years of growth [12, 21].
- Requires a minimum of 180 days of growing season per annum [7].
- **Requires over 700 mm/year of rainfall, well distributed throughout the year** (optimally from 1000 to 1200 mm/year [25] unless there are sufficient water reserves in the ground, in which case 500 mm/year may be enough) [12, 28, 5, 7, 25, 10, 17].
- **Resistant to drought** thanks to its tap root: on soft ground, it can draw water from deep underground [7, 20], but the minimum rainfall during the growing period must remain above 100-150 mm [12, 18]; more drought resistant in the juvenile stage [31].

- Fairly sensitive to wind [77: stems may break in storms or growth may lean away from frequent winds in a constant direction (e.g. mistral, etc.). Plant the trees on sites sheltered from the wind [14, 5] or plant quick-growing hedge-type vegetation to protect them. [31, 13].

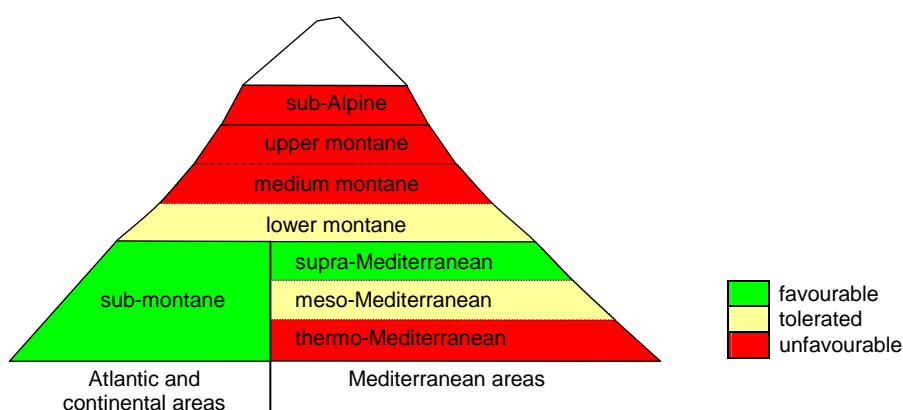
Summary of bioclimatic requirements and sensitivity of the Common walnut

Warmth Requirement	Sensitivity					
	cold	late frosts	early frosts	Sticky snow	wind	drought
High	Moderate	Moderate	High	Low	Moderate	Low

Vegetation stages

- Occurs essentially in the **sub-montane stage** up to 700-800 m [12, 16, 5, 7, 31].
- Although found on higher stages, it can be planted at up to 1000 m in the protected valleys of the Southern Alps [5, 7, 2]. Elsewhere, the timber is likely to incur frost crack above 800 m. (invisible from the outside) [5, 7].

Distribution of the Common walnut according to vegetation stages



Temperament

- An open-field species thriving in **full light** [5, 7, 30, 22, 10]: tolerates shade in its early years, but at the expense of growth. Light-demanding in its mature phase [5].
- **Very sensitive to competition** from other forest species [10, 20].
- Sensitive to sun scald at a young age [27, 7] (while the bark is smooth).
- **Phototropic** [5, 7].
- Exposure: favours south-west facing slopes in cool climate areas. Avoid south-facing slopes in hot climates [14, 2].



Sensitivity to competition for light	Phototropic tendency
High	High

Climatic limits

- Temperature: Annual average: at least 7° C [5].
 Absolute minimum: -30° C [5, 7], but varies with the origin of the tree.
 Absolute maximum: probably high (the species has withstood heatwaves such as in 2003 in France, but this can depend on the origin of the tree [Becquey J., pers. comm., 2012]).

SOILS

Occurs on rock and a variety of geological formations [5].

Water and drainage

Water supply:

- **Water demanding** species, thrives in humid to moderately humid conditions [30], requiring soils with plentiful water reserves [19, 8, 14, 13] for good growth. Moderate potential on moderately humid sites [19].

Waterlogging:

- The species is **very sensitive to waterlogging**, even temporary, to at least 80 cm in depth [14, 5, 7, 17]. Soils to avoid are therefore wet soils and areas with a permanent water table close to the surface (ideally the water table should be deeper than 1.5 m [17]).

Drainage and excess water

		a	b	c	d	h	i	e	f	g
Natural drainage		excessive	good	moderate	imperfect	poor	very poor	partial	virtually non-existent	non-existent
water table e	temporary	redox horizon with rust patches	absent or > 90cm	60-125cm	40-80cm	20-50cm	0-30cm	20-50cm	0-30cm	
	permanent	reductive waterlogged horizon	-	-	-	-	-	> 80cm	40-80cm	< 40cm

favourable
 tolerated
 unfavourable

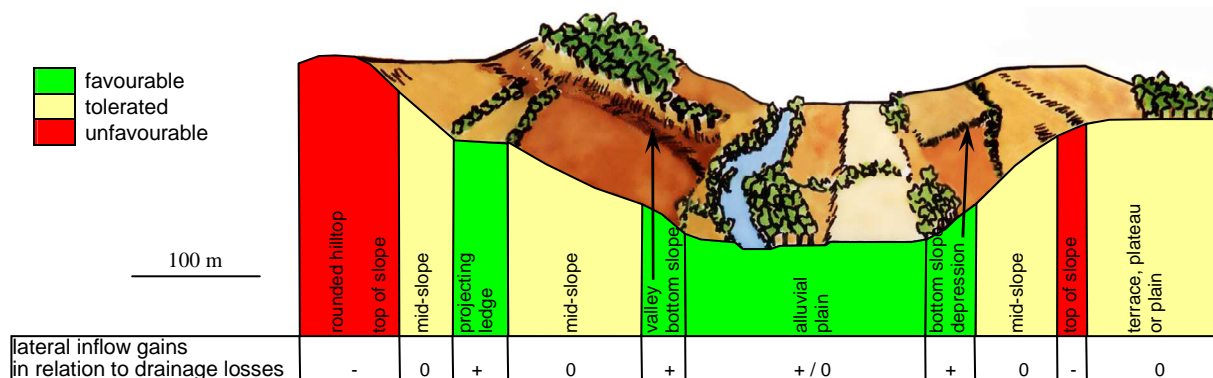
(From the Species Ecology file, Ministry of the Walloon Region, 1991, amended [27])

Topographic situations:

- Favourable: alluvial plains (the most favourable areas when stagnant water is absent), small enclosed side valleys [17], slopes with a good water supply (deep soils, especially in concave areas [7]), depressions on plateaus.
- Unfavourable: frost pockets and valley bottoms with stagnant air (narrow valleys, basins) [14, 5, 7].

Favourable topographic situations for the Common walnut in terms of water supply

(involved in the morpho-pedological compensations, to be modulated according to the other site characteristics)



Texture and materials

- The texture of the surface horizons should be balanced: clay-sand loam or sand-clay loam [11, 30]. Waterlogging may occur in a rainy climate on clayey soils, especially on the surface. The ideal soil composition is as follows: clay = 18-25%, loam = 30-50% and sand = 30-50% [28, 18, 25]. The proportion of clay may be greater at depth. A sandy texture is appropriate if there is a plentiful water supply (water table present) [11, 7].
- **Surface** horizons must be **friable, well structured and porous**, lumpy or sub-angular polyhedral [11].
- The soil must be at least 80 cm **thick** with **good water retention** [12, 16, 5, 11, 7, 10, 20].
- Grows on stony soils if rooting is possible at 80 cm. It can be even found on scree [20]. To ensure good productivity, particularly in dry climates, the coarse component of the surface horizons should be less than 10% [11].

Textures favouring growth of the Common walnut

(involved in the morpho-pedological compensations, to be modulated according to the climate and soil)

very sandy S	coarse SA, LS, SL	loamy LmS, Lm, LI, LIS	intermediate LAS, LSA, LA, AL	clayey A, AS	very clayey Alo
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favourable
 tolerated
 unfavourable

Favourable:

- Thick brown lime or calcium soils at the bottom of slopes (colluvium) [27, 19].
- Neutral or slightly acidic, deep, loamy or predominantly sandy valley or plain soils (alluvial) [11, 13].

Unfavourable:

- Compact or wet clay soils (pseudo gley) [12, 21, 5, 11, 7, 32, 25, 10]; very loamy soil crusts [7]; thin or highly filtering soils [2].

Nutrients

Nutritive elements:

- Should be planted on **rich soils for optimum production** [14, 7, 2], but **adapts to moderately fertile soils if the water supply is sufficient** [9]. Optimum growth on rich soil with pH = 6.5 to 7.5 [12, 11, 7, 25, 30, 10], but tolerates a pH of 5.5 to 8.5 [2]; avoid poorer soils with pH < 5.5 [5, 7].
- Optimum humus: calcium to mesotrophic mull [30].
- The growth of the Common walnut is closely linked to the **C/N ratio** and to a lesser extent to the P₂O₅ content; for good growth, mineral nutrients must be readily available with sufficient organic matter and phosphoric anhydride: 1.5-2% organic matter [12, 11, 25].
- On poor soils where growth is slow, the timber is highly coloured and veined and thus suited to top-of-the-range veneer and high-quality cabinet making (unique furniture pieces); fast-growing trees on rich soils usually produce light-coloured timber suitable for cladding and industrial cabinet making (mass production) [7].
- Sensitive to soil salinity (electrical conductivity < 1.5 dS/m) [12, 21].

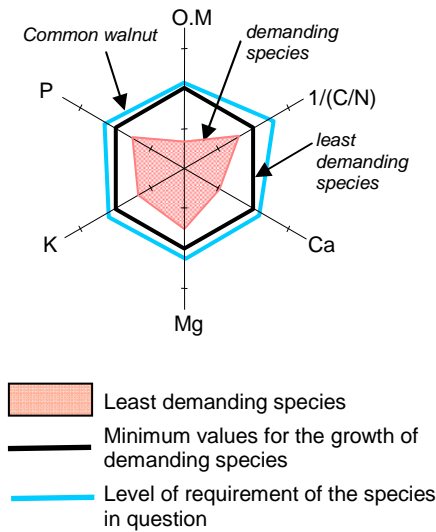
Lime in fine soil:

- **Grows on fertile alkaline soils** [30, 26], but avoid pH > 7.5-8.5 with excessive active lime that causes chlorosis [12, 5, 11, 7, 10], especially when present in surface horizons (over 40 cm) [14].

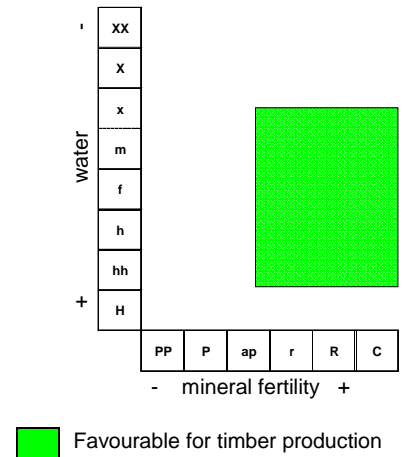
Summary of water and nutrient requirements and sensitivity of the Common walnut for

Water requirements	High
Sensitivity to temporary waterlogging	High
Nutrient requirements (Ca, Mg, K)	High
Nitrogen (and phosphorus) requirements	Moderate
Sensitivity to lime in fine soil	Low

Mineral nutrition of the Common walnut



Ecogram for the Common walnut
(according to Rameau *and al.*, 1989, amended)



DYNAMIC BEHAVIOUR AND CHARACTERISTICS

- **Post-pioneer** species [30].
- **Adversely affected by herbaceous competition** [26].
- Sensitive to Armillaria root rot (*Armillaria mellea*) and Phytophthora (*Phytophthora cinnamomi*) [7, 9]. In Spain, *Zeuzera pyrina* is a serious parasite, especially near fruit plantations [1].



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MAIN FACTORS FOR THE PRODUCTION OF GOOD QUALITY TIMBER

Limiting factors

- poor water supply, hydromorphy
- excessive competition for light
- early frosts, sharp temperature drops in winter, strong winds

Favourable factors

- deep, aerated, non-acidic soils, cool but not wet, sunny exposure, sufficient rainfall or abundant water reserves in the soil

Autecology of the **BLACK WALNUT**

Juglans nigra L.

Fr. : Noyer noir

Ger. : Schwarznuss

Sp. : Nogal negro Americano; Cat.: Noguier Negro

It. : Noce nero



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This description is limited to features distinguishing the Black walnut from the Common walnut.

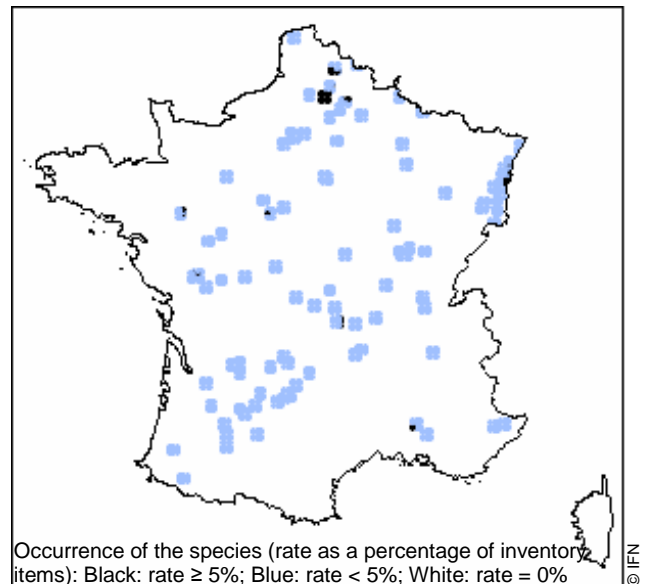
GEOGRAPHICAL DISTRIBUTION

- **Natural range:** Temperate eastern United States (from Atlantic coast to Nebraska, Kansas and Oklahoma in the west and from the Canadian border to Texas, Missouri, Alabama and Georgia to the south) [9]. This broad range explains why the species behaves variably, depending on the [7] origins of the plants.
- **Introduced in France in 1629** [30, 22].

Distribution of Black walnut in North America
(Williams, 1990 [33])



Distribution of Black walnut in France



CLIMATE AND TEMPERAMENT

Bioclimatic conditions

- **Sensitive to late frost** due to early budding (mid-April in the south-west, but variable according to the origin of the plants) [10, 9]; can be **very sensitive to early frost** [10].
- Root growth observed at ground temperature above 4 °C, with optimum root growth at 19 °C [23].
- Sensitive to gales during the growing period (gusts of wind, thunderstorms) causing breakage of branches or even trunks [7]. However, the stems grow vertically even in steady constant winds (mistral, etc.)

Summary of bioclimatic requirements and sensitivity of the Black walnut

Warmth Requirements	Sensitivity					
	cold	late frost	early frost	sticky snow	wind	drought
Moderate	Moderate	High	Moderate	Low	High (summer, thunderstorms)	High

Vegetation stages

- Identical to Common walnut, except at < 800 m altitude.

Temperament

- Light: less demanding than the Common walnut, **growing well, even thriving, in a forest environment** [22] [7].
- **Withstands competition better than the Common walnut** [7, 10].
- **Almost non-phototropic** [77].
- Lateral shelter during the first years is beneficial [10].



Sensitivity to competition for light	Phototropic tendency
Moderate	Low

Climatic limits

- **Resistant to cold** [9] down to -35 °C [26, 10].
- Rainfall: must be frequent and well-distributed (minimum 900 mm per year, [12]); **vulnerable to summer drought** (poor stomatal control and quick leaf fall) [10, 23], but withstands very hot weather if there are abundant water reserves.
- Atmospheric humidity favours the species.
- Requires a growing season of at least 140 days, ideally 170 days [6, 7].

SOILS

Water and drainage

Water supply:

- **More demanding than the Common walnut.**
- Growth is closely linked to the water supply (rain or ground water reserve) [15]. The species is severely affected by droughts [12].

Waterlogging:

- Withstands temporary waterlogging [12, 7, 29], but **excessive water at the beginning of the growing period is detrimental** [15].
- **Avoid waterlogged soils to less than 60 cm in depth** [10].

Drainage and excess water

		a	b	c	d	h	i	e	f	g
Natural drainage		excessive	good	moderate	imperfect	poor	very poor	partial	virtually non-existent	non-existent
water table	temporary	redox horizon with rust patches	absent or > 90cm	60-125cm	40-80cm	20-50cm	0-30cm	20-50cm	0-30cm	
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■ favourable
■ tolerated
■ unfavourable

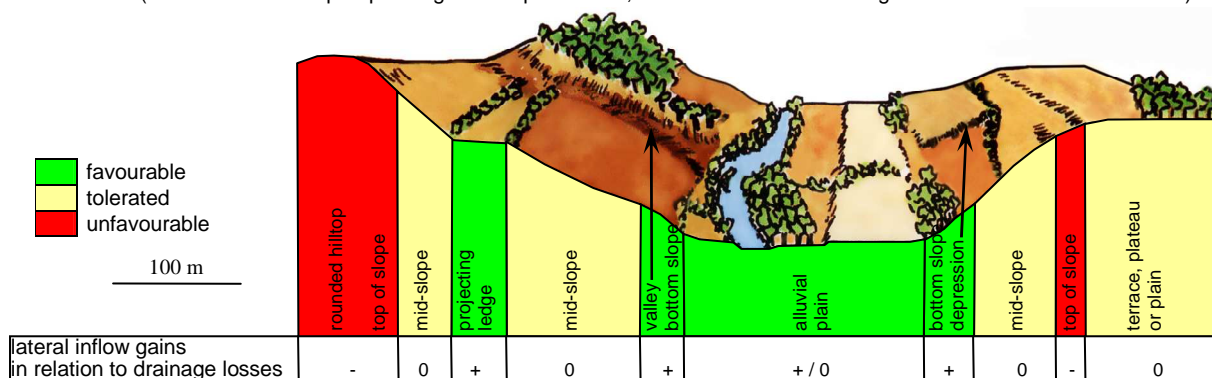
(from Species Ecology file, Ministry of the Walloon Region, 1991, amended [27])

Topographic situations:

- Alluvial plains (valleys of the Rhine and its tributaries, Saone and Yonne valleys, etc.) [7] and alluvial terraces; slopes, but avoid dry exposure (south, west) [6, 29].
- Grows well on the rich and cool areas of slopes and alluvial plains, especially in the Aquitaine basin on alluvial soils traditionally planted with poplar [19].

Favourable topographic situations for the Black walnut in terms of water supply

(involved in the morpho-pedological compensations, to be modulated according to the other site characteristics)



Texture and materials

- the nature of the soil is the main factor limiting the **Black walnut tree**, which is **more demanding than the Common walnut** [8, 6, 29].
- Prefers **relatively balanced and well aerated soils** [30, 10, 29]; beware of excessively filtering soils, which are too dry on coarse sand or alluvium.
- Requires soils at least 1 m thick; if less, e.g. 60-80 cm, the ground must be very well aerated and constantly supplied with water (water table at a maximum depth of 1.50-2 m) [7, 29].
- **Avoid: compact clay soils and pseudo gleys** (with an impermeable layer), **poorly structured loams and stony soils** [7, 10, 29].

Textures favouring growth of the Black walnut

(involved in the morpho-pedological compensations, to be modulated according to the climate and soil)

very sandy S	coarse SA, LS, SL	loamy LmS, Lm, Li, LIS	intermediate LAS, LSA, LA, AL	clayey A, AS	very clayey Alo	■ favourable ■ tolerated ■ unfavourable
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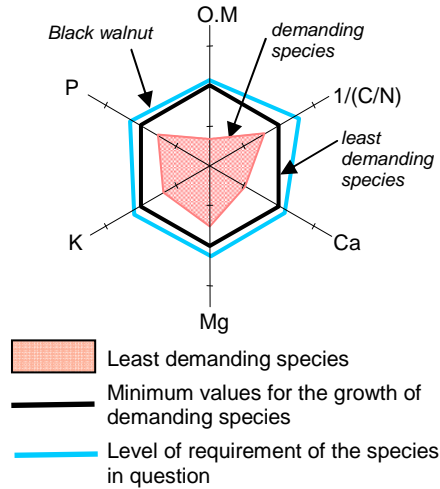
Nutrients

- Although not lime-intolerant, it **does not grow well on limestone** and is more tolerant of acidity, which corresponds to a range of pH from 5 to 7.5 [12, 7, 10, 25].
- Rather **demanding in terms of nutrient minerals**: gives the best results on rich sites [11, 19].
- Ideal: deep, well-drained loamy soils, rich in organic matter and minerals, such as alluvial soils (ash and elm stands) [29].

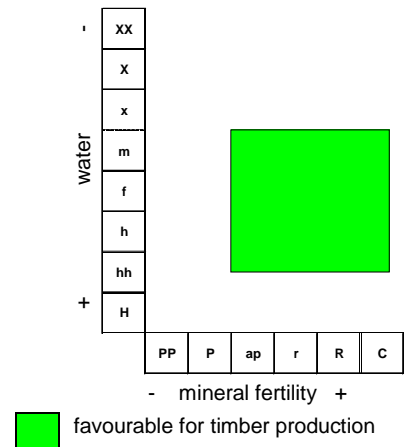
Summary of water and nutrient requirements and sensitivity of the Black walnut

Water requirements	High
Sensitivity to temporary waterlogging	Low
Nutrient requirements (Ca, Mg, K)	High
Nitrogen (and phosphorus) requirements	Moderate
Sensitivity to lime in fine soil	Moderate

Mineral nutrition of the Black walnut



Ecogram for the Black walnut (according to Rameau *et al.*, 1989 amended)



DYNAMIC BEHAVIOUR AND CHARACTERISTICS

- **Post-pioneer** species [30].
- Not sensitive to Armillaria root rot (*Armillaria mellea*) [7].
- Grows **better in forest conditions than the Common walnut**, in mixed, high-density stands.



MAIN FACTORS FOR THE PRODUCTION OF GOOD QUALITY TIMBER

Limiting factors

- In particular, insufficient or irregular water supply on compact or excessively filtering soils
- Dry air, strong winds when in leaf and late frost. However, these risks can be mitigated by planting black walnut in protected locations or in a forest environment with appropriate tree care (form pruning)

Favourable factors

- Aerated and deep soils, cool but not wet, preferably rich but not acid, sunny exposure with sufficient rainfall or abundant water reserves in the soil
- high atmospheric humidity

Autecology of the HYBRID WALNUT

Juglans x intermedia

Commercially available in France under the names:

MJ209 x RA = *Juglans major* 209 x *Juglans regia* (most common)

NG23 x RA = *Juglans nigra* 23 x *Juglans regia*

NG38 x RA = *Juglans nigra* 38 x *Juglans regia*

Fr. : Noyer hybride

Ger. : Echte Walnuss

Sp. : Nogal híbrido. Cat. : Noguer híbrid

It. : Noce ibrido



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The ecological requirements for this species are similar to those of the Common and Black walnut, with more or less marked characteristics of one or the other:

- Hybrid NG23 x RA is a little less sensitive to winter frost than the Common walnut and less sensitive to late frost than the Black walnut, due to later budding [12, 8, 5, 7].
- Hybrid MJ209 x RA appears more sensitive to cold (T. Avg. annual > 8 ° C) than the hybrid NG23 x RA [3].
- This species appears less phototropic and less sensitive to shade than the Common walnut [5].
- Tolerates slightly acidic soils, up to pH 5 [3, 7, 10]; the hybrid MJ209 x RA is not sensitive to active lime and alkaline soils, but appears more sensitive to acid soils [3, 12, 10].
- Takes over most distinctly from its parents (the Common and Black walnut) on sites with a moderate water supply. Resistance to droughts and heatwaves appears to be intermediate between those of its parents.
- Optimum: well-structured and aerated clay-loam soils.
- Avoid heavy, waterlogged soils with an insufficient rate of saturation of exchangeable bases and pH values below 4 (oligotrophic soils) [3, 1].
- Very sensitive to herbaceous competition [3].



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Comparison of requirements and site susceptibilities for walnut trees (According to Becquey, 1997, amended [8])

Criteria		Common walnut	Black walnut	Hybrid walnut
Soil	Water requirements	High	High	High
	Susceptibility to temporary waterlogging	High	Low	Moderate
	Nutrient requirements	High	High	High
	Susceptibility to active lime	Low	Moderate	Low
Climate	Warmth requirement	High	Moderate	Moderate
	Rainfall requirement (during the season)	Moderate	High	Moderate
	Susceptibility to cold	Moderate	Moderate	Moderate
	Susceptibility to late frost	Moderate	High	Moderate
	Susceptibility to early frost	High	Moderate	Moderate
	Susceptibility to wind	Moderate	High (summer, thunderstorms)	Moderate
	Susceptibility to drought	Low	High	Moderate
Light	Susceptibility to competition for light	High	Moderate	Moderate
	Phototropic tendency	High	Low	Moderate



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■ Factsheet references: **Lestrade M., Becquey J. Coello, J. Gonin P., 2012** - Autecology of the Common walnut (*Juglans regia* L.), Black walnut (*Juglans nigra* L.) and Hybrid walnut (*Juglans x intermedia*). In : Gonin P. (coord.) et al. - *Autecology of broadleaved species*. Paris : IDF, 2013, 65 p.

BIBLIOGRAPHIC REFERENCES - WALNUT SPECIES

- 1 Aleta N., Vilanova A., 2006 - El nogal híbrido. Departament d'Arboricultura Mediterrània - IRTA - Centro de Mas Bové. *Navarra Forestal* n° 13, p. 18-21
- 2 Alexandrian D., 1992 - *Guide du forestier méditerranéen. Tome 3 : Essences forestières*. Cemagref, 97 p.
- 3 Arnold E., Frank R., Hein S., Ehring A., 2011 - Croissance, qualité et mortalité du Noyer hybride sur différentes stations dans le Bade-Wurtemberg (Allemagne). *Revue Forestière Française*, LXIII – 4, p. 425-434
- 4 Aussenac G., Guehl J.-M., 1994 - Dépérissements et accidents climatiques. *Revue Forestière Française*, XLVI – 5, p. 458-470
- 5 Barengo N., 2001 - *Noyer commun*. *Juglans regia L...* Chaire de sylviculture EPFZ, Direction fédérale des forêts OFEFP, 8 p. (SEBA, Projet Favoriser les essences rares)
- 6 Baughman M., Vogt C, Breneman D., 1997 - *Black Walnut management*. Minnesota Extension Service, University of Minnesota, 80 diapositives (diaporama)
- 7 Becquey J., 1997 - *Les noyer à bois*. 3^e édition. IDF, 143 p.
- 8 Becquey J., 2009 - *Quel noyer planter ?* [en ligne]. 1 p. Disponible sur : http://www.foretriveefrancaise.com/data/info/491924-fiche_choix_noyer_2009.pdf (consulté le 11.05.12 ; extrait du manuel « Les noyers à bois » 3e édition, IDF, 1997, annexe 3, p. 133, m.a.j. janvier 2009)
- 9 Bergougnoux F., Grosperre, P., 1981 - *Le noyer*. Paris, Infulec, 187 p.
- 10 Bosshardt C., 1985 - *Étude de quelques feuillus précieux dans le centre de la France : le Frêne, le Merisier, les noyers*. Nogent/Vernisson : Enitef, Cemagref, 154 p. + annexes
- 11 Chéry P., 1998 - *Typologie des sols de stations à noyer à bois en Dordogne*. Enita Bordeaux - GDNB Aquitaine, 12 p.
- 12 Coello J., Pique M, Vericat P., 2009 - *Producció de fusta de qualitat: plantacions de noguera i cirerer*. *Departament de Medi Ambient i Habitatge Centre de la Propietat Forestal*.
- 13 Crave M.-F., 1990 - L'effet du vent sur les noyers. *Forêt-entreprise* n° 66, p. 13-17
- 14 CRPF d'Ile de France et du Centre, 2007 - *Les noyers à bois*. CRPF IdF-C, 4p.
- 15 Dudek D.M., McClenahan J.R., Mitsch W.J., 1998 - Tree growth responses of *Populus deltoides* and *Juglans nigra* to streamflow and climate in a bottomland hardwood forest in central Ohio. *The American Midland Naturalist* 140 (2), p. 233-244
- 16 Favre C., 2008 - *Introduire et cultiver du noyer*. SFFN Etat de Vaud (Suisse), 2 p. (Fiche de diagnostic proposée pour la plantation de noyers suite à l'étude « Projet d'implantation de noyers à bois dans le 8e arrondissement »)
- 17 Garavel L., 1959 - *La culture du noyer*. Paris, J.-B. Baillière, 294 p.
- 18 Giannini R., Mercurio R., 1997 - *Il Noce comune per la produzione legnosa*. Bologna, 302 p.
- 19 Gonin P., 1994 - *Croissance des plantations sur les stations à intérêt forestier des coteaux et vallées de Midi-Pyrénées situés à l'est de la Garonne*. Toulouse : CETEF Garonnais, CRPF Midi-Pyrénées, 79 p.
- 20 Guinier Ph., 1953 - Le noyer producteur de bois. *Revue Forestière Française* n°3, p. 157-177
- 21 Illan A., 2004 - El nogal común *Juglans regia L.*. *Navarra Forestal* n°7, p.13-15
- 22 Jacamon M., 1987 - *Guide de dendrologie. Arbres, arbustes, arbrisseaux des forêts françaises. Tome II Feuillus*. Nancy : ENGREF, 256 p.
- 23 Kuhns M.R., 1985 - Root growth of black walnut trees related to soil temperature, soil water potential, and leaf water potential. *Forest Science* Vol. 31, n° 3, p. 617-629

- 24 Leslie C., Granahan G.H., 1998 - The origin of the walnut. *In* : Ramos, D.E., éd. Walnut production manual. Publ. 3373. Oakland, CA, University of California: p. 3-7
- 25 Luna F., 1990 - Exigencias Ecológicas / Densidad de plantación. *En* El Nogal. Producción de fruto y madera. Mundi-Prensa.
- 26 Martin B., 1979 - *Les Noyers. Physiologie, génétique, reboisement*. Nancy : ENGREF, 67 p.
- 27 MRW (Ministère de la région Wallonne), 1996 - *Le fichier écologique des essences. Tome 3*. Namur : MRW, 203 p.
- 28 Mohni C., Pelleri F., Hemery G.E., 2009 - The modern silviculture of *Juglans regia* L : a literature review. *Die Bodenkultur*, Vol. 60, p. 19-32
- 29 Ponder F., 1981 - *Some guidelines for selecting black walnut planting sites*. USDA, Forest Service, rapport technique NC-74, p. 69-72
- 30 Rameau J.C., Mansion D., Dumé G., 1989 - *Flore Forestière Française ; tome 1 : plaines et collines*. Institut pour le Développement Forestier, 1785 p.
- 31 SEBA, 2004 – *Noyer, Juglans regia L.* [en ligne]. 4 p. (SEBA, Documentation des cours). Disponible sur : http://www.wm.ethz.ch/sebapub/seba_2/SEBA2_KD_wnu_2004_FR.pdf (consulté le 11.05.12)
- 32 Vassor J., 1995 - 16 ans d'expérience sur les noyers en Touraine. *Forêt-entreprise* n°103, p. 52-55
- 33 Williams R.D., 1990 - *Juglans nigra* L. black walnut. *In* : Burns, Russell M.; Honkala, Barbara H., technical coordinators. *Silvics of North America*. Vol. 2. Hardwoods. Agric. Handb. 654. Washington, DC: U.S. Department of Agriculture, Forest Service, p. 391-399