

The Walnut Tree: Allelopathic Effects and Tolerant Plants

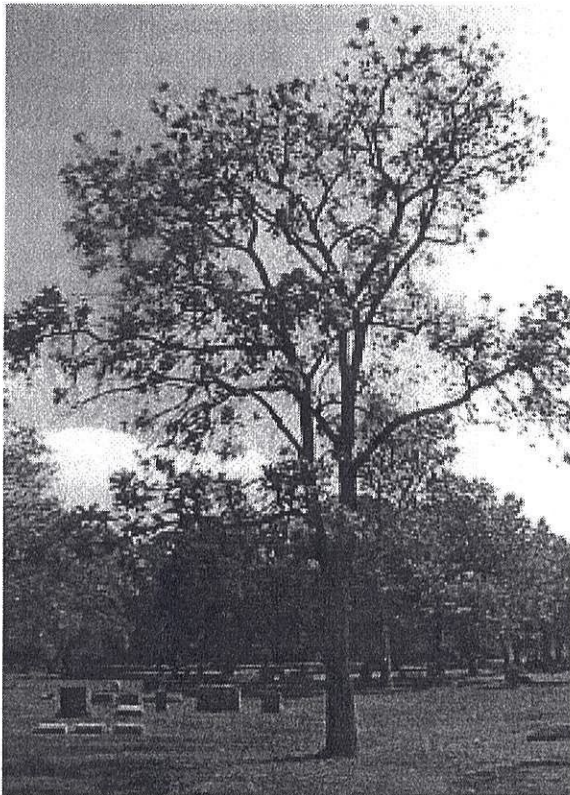
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Walnut tree characteristics

Walnut is the common name given to twenty species of deciduous trees in the genus *Juglans*, of which six species are native to the United States. The black walnut, *Juglans nigra*, which is native to Virginia, grows from Maine west to southern Michigan and south to Texas and Georgia.

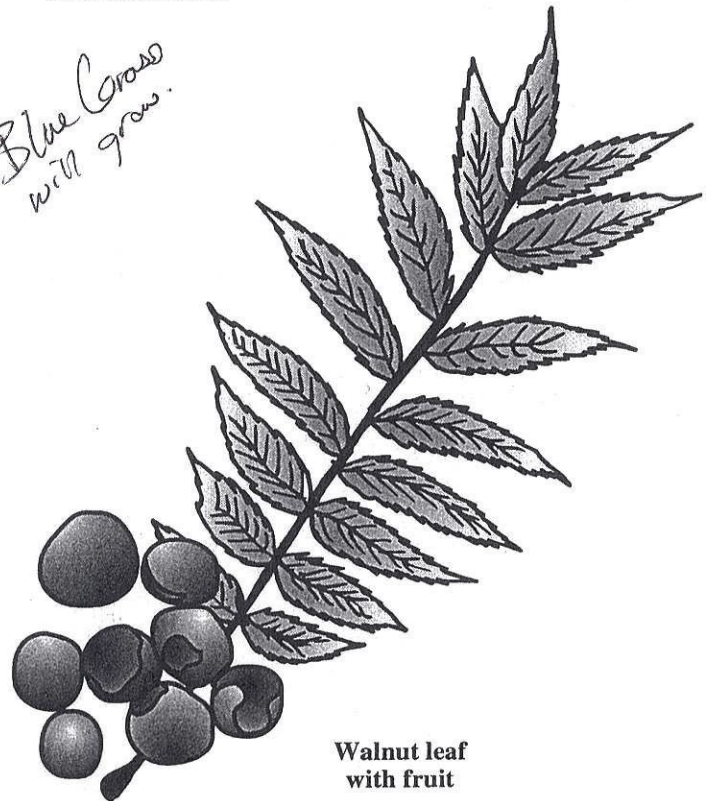
Black walnut is the tallest of the walnuts, with the potential to reach 100 feet. The compound leaves of walnuts are spaced alternately along the branches. Each

leaf is divided into an odd number—usually from 7 to 23—of small yellowish green leaflets. Walnuts are monoecious, with male flowers borne in long, unbranched, drooping catkins and female flowers borne singly or in short spikes. The walnut fruit is a nut, borne singly or in pairs, and enclosed in a solid, non-splitting green husk. The edible, oil-rich nut kernel is enclosed in a thick, hard, ridged, black shell. Black walnut heartwood is heavy, hard, strong, and durable, with a chocolate-brown color prized by furniture manufacturers and many other industries.



Walnut Tree

Blue Grass
will grow.



Walnut leaf
with fruit

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Understanding allelopathy

Allelopathy is a complex phenomenon which Pliny the Elder, a Roman natural science author, first wrote about in 77 A.D. In his writings he noted the toxic effects of black walnut on neighboring plants in the landscape.

Allelopathy involves a plant's secretion of biochemical materials into the environment to inhibit germination or growth of surrounding vegetation. Allelopathy enhances tree survival and reproduction. Some plants that produce allelochemicals can be used in production as cover crops to control weeds. Researchers are presently attempting to breed crops and landscape plants that are allelopathic to weeds.

Allelochemicals are metabolic by-products of certain plants that, when introduced into the environment, cause growth inhibition by affecting physiological processes such as respiration, cell division, and water and nutrient uptake. Symptoms of "allelopathic effects" include leaf wilting and yellowing, or death of part or all of a plant.

Black walnut and allelopathy

Though grown primarily for its wood and nuts, black walnuts are often found growing on landscape sites where they serve primarily as shade trees. When certain other landscape plants are planted near or under this shade tree they tend to yellow, wilt, and die. This decline occurs because the walnut tree produces a non-toxic, colorless, chemical called hydrojuglone. Hydrojuglone is found in leaves, stems, fruit hulls, inner bark and roots. When exposed to air or soil compounds, hydrojuglone is oxidized into the allelochemical juglone, which is highly toxic.

Several related trees such as English walnut, hickories and pecan also produce juglone, but in smaller amounts compared to black walnut. Juglone is one of many plant-produced chemicals that can harm other plants in a process known as allelopathy. (Additional common landscape trees with allelopathic properties: sugar maple, tree-of-heaven, hackberries, southern waxmyrtle, American sycamore, cottonwood, black cherry, red oak, black locust, sassafras, and American elm.)

Juglone in the soil

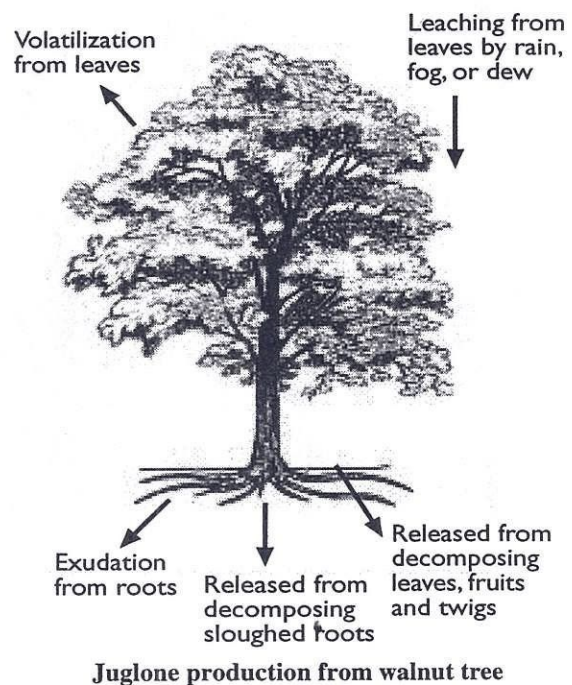
Juglone is exuded from all parts of the walnut tree. Juglone can affect other plants either through root contact, leakage or decay in the soil, falling and decaying leaves, or when rain leaches and drips juglone from leaves and branches onto plants below. Plants located beneath the canopy of walnut trees are most at risk because juglone from the roots and fallen leaves accumulates there.

Although juglone has low water solubility and does not move far in the soil, small amounts may be injurious to sensitive plants. Plant roots can encounter juglone when they grow within 0.5 - 0.25 inches from a walnut root. Walnut roots can extend in the soil well beyond the crown or drip line of the tree, affecting susceptible plants far from the black walnut.

The accumulation and depletion of toxins in the soil is affected by factors such as soil type, drainage, aeration, temperature and microbial action. Soil microorganisms ingest allelochemicals as energy sources, and metabolic decomposition can render the chemicals non-toxic to plants. When soils are well drained and aerated, a healthy population of aerobic microorganisms can accelerate this process.

Wet, poorly aerated soil, very common in many urban areas, discourages microbial growth. Plants sensitive to the walnut tree's toxic effect may be at a higher risk when planted in heavy urban soils that lack organic matter. Toxins adhere to organic matter rather than being absorbed by plants, and organic matter also encourages a healthy soil microbial population.

Mycorrhizal fungi are commonly associated with forest tree roots and are considered necessary for normal uptake functions. Allelochemicals can disrupt the uptake process by damaging the root hairs or by inhibiting mycorrhizal populations in the soil. These different soil factors have an effect on the accumulation or depletion of juglone produced by the black walnut tree.



Reducing allelopathic effects

- * Regularly clean up all fallen leaves and fruit from the black walnut tree, keeping debris away from desired landscape plants.
- * Compost plant debris to degrade any toxins present in the compost pile, and to detoxify the compost. If composting is impractical, do not use any part of the walnut tree as compost or mulch for other plants.
- * Maintain high organic matter levels in the soil because organic matter encourages healthy soil microbial populations that can metabolize toxins.
- * Plant tolerant trees, shrubs, vines, ground covers, flowers and grasses under walnut trees, or in areas that might contain walnut roots.

Tolerant grasses

Tall fescue and Kentucky bluegrass grow well near black walnut except during drought conditions when soil moisture is low. When moisture is adequate these grasses may grow better under walnut trees than in other parts of the lawn, possibly because the soil may be more basic. Soil under black walnuts tends to be alkaline, with the pH often 0.7 points higher than beyond the roots, thus influencing the growth of many different plants.

Tolerant trees and shrubs

arborvitae, American
ash, white
barberry
beech, American
birch, black; 'Heritage' river
boxelder
buckeye, Ohio
catalpa
cherry, black
crabapple
daphne
dogwood, flowering
elderberry
elm, American
forsythia
fringetree
goldenraintree
globeflower
gum, black
hawthorn
hemlock, Canadian
hibiscus
hickory
holly, American
honeylocust
honeysuckle, amur; tatarian
hydrangea
lilac
locust, black
maple, red; sugar; black; Japanese
ninebark
oak, white; red; scarlet
pawpaw
pear, callery
pine, Virginia
privet
red cedar, eastern
redbud, eastern
sassafras
serviceberry
silverbell, Carolina
spruce, Norway
sumac
sweetgum
sycamore
tulip tree
viburnums (some species)
witchhazel

Tolerant vines, ground covers and flowers

anemone
aster
astilbe
bee balm
begonia
bittersweet
calendula
clematis (virginsbower)
coral bells
creeper, Virginia
daffodil
daisy, shasta
daylily
evening primrose
fern
geraniums, hardy
goldenrod
grape, wild
hollyhock
hosta
hyacinth, grape; oriental
iris, siberian
ironweed
jack-in-the-pulpit
lamb's ear
liriope
lobelia
may apple
morning glory
mullein
phlox
primrose
raspberry, black
rose, wild
rudbeckia
scilla
sedum
speedwell
spiderwort
St. John's wort
sunflower
trillium
tulip
violet
wisteria
yarrow

Plants damaged by juglone

apple
azalea
birch, white
blackberry
blueberry
chrysanthemum
crocus, autumn
forget-me-not
grape, domestic
lily-of-the-valley
linden
mountain laurel
peony
pine
potato
rhododendron
thyme
tomato

References

- Brooks, M. G. 1951. Effect of black walnut trees and their products on other vegetation. Bulletin 347, West Virginia University, Agricultural Experiment Station, Morgantown, WV.
- Coder, K.D. 1999. Allelopathy in trees. *Arborist News* 8(3):53-60.
- Rietveld, W.J. 1983. Allelopathic effects of juglone on germination and growth of several herbaceous and woody species. *J. of Chemical Ecology* 9(2):295-308.