

## 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 kernal 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



Walnut leaf with fruit

## 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.

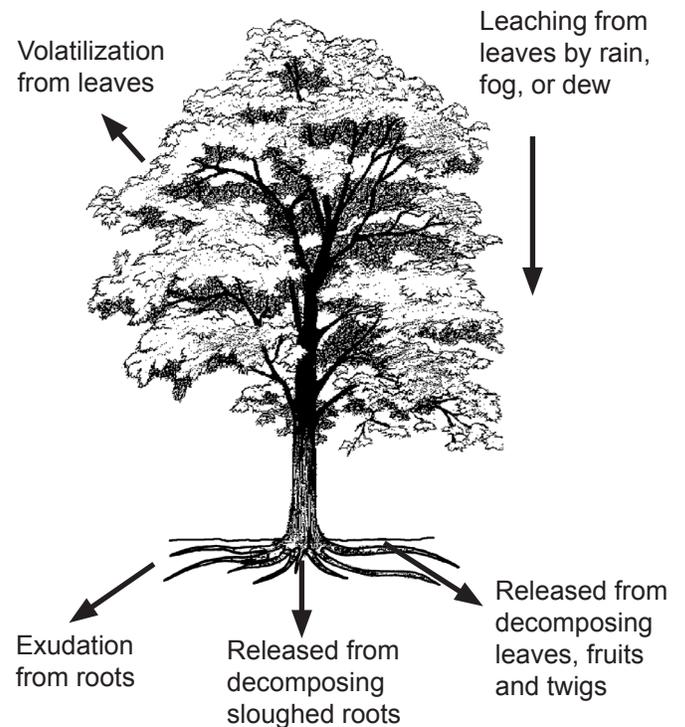
Although juglone has low water solubility and does not

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 all have an effect on the accumulation or depletion of juglone produced by the black walnut tree.



Juglone production from 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

## **Tolerant vines, ground covers and flowers**

### **(cont.)**

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.