We compared the responses to root-zone waterlogging of seedlings of *Juglans regia*.

Additional index words. *Juglans nigra*, *Juglans hindsii*, rootstocks, root-zone flooding

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have been established (4).

Commercial use of this growth regulator would require consistent beneficial responses. The possibility that BA may be detrimental to plant growth and yield indicates that it has limited potential for commercial use on strawberry at this time.

### Literature Cited


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**Response of Eastern Black Walnut and Northern California Black Walnut Seedlings to Waterlogging**

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Additional index words. *Juglans nigra*, *Juglans hindsii*, rootstocks, root-zone flooding

**Abstract.** We compared the responses to root-zone waterlogging of seedlings of *Juglans nigra* L. and *Juglans hindsii* (Jeps.) Rehder. On the average, the two species did not differ in sensitivity to waterlogging, but substantial variation in sensitivity between individual plants within phenotypes was observed. Both species are highly sensitive to root-zone waterlogging.

*Juglans* species (*J. hindsii*, *J. regia*) or hybrids ('Paradox', *J. hindsii* × *J. regia*) employed as rootstocks in the California walnut industry are considered to be very sensitive to deficient soil aeration (4, 5). Differences in tolerance to anaerobic conditions among types of rootstock used or of potential use have been established (4).

*Juglans nigra* L. has been extensively used as a rootstock for nut-producing cultivars of *J. regia* L. in France (8, 11) and has received some attention in eastern Europe (14). In the United States, increased use of *J. nigra* as rootstock for scions of this species for timber, nut production, and germplasm maintenance is anticipated (1, 9).

Excessive soil moisture is not clear. From field observations, *J. nigra* has been described as colonially tolerant (19), somewhat tolerant (2), moderately sensitive (12), and very sensitive (13). In a comparison with *J. regia*, *J. nigra* appeared to be more tolerant to waterlogging (17). With the latter, however, only four or five seedlings per treatment were employed, and large variations in response to flooding between individuals in seedling populations have been demonstrated (4, 16).

To clarify the relative tolerance to waterlogging of *J. nigra*, we made direct comparisons of the responses of *J. nigra* and *J. hindsii* in a comparison to *J. regia* and 'Paradox' hybrid (4).

Seedlings were obtained from two clones of *J. hindsii* routinely used as sources of seedlings. For *J. nigra*, seeds were from 'Ohio', 'Thomas', and an unnamed clone originally from the Tennessee Valley Authority. Seedlings were grown in pasteurized sand in milk cartons (0.95 liter) in a greenhouse. When 6- to 12-week-old and about 30 cm or more in height, waterlogging treatments were initiated as described previously (4). Tap water was maintained about 2.5 cm above the root medium. Root temperature was controlled at 23°C in a water bath. Air temperature was regulated only within broad limits from about 10°-16° at night and to about 22°-32° during the day. Epinasty and chlorosis, wilting, and necrosis of leaves were used as indicators of root damage (4). Nonflooded plants did not show these symptoms. Observations were made daily, and individual plants were removed from treatment when symptoms were clearly present.

Twenty plants of similar size and appearance of each of two genotypes were waterlogged on seven separate occasions. On four of these occasions, both *J. nigra* and *J. hindsii* seedlings were included in each treatment to minimize possible differences in aerial conditions. There were two other trials that included a single genotype of *J. nigra*.

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**Fig. 1.** Average survival curves for seedlings of *J. nigra* 'Ohio' (*○*), Tennessee clone (*●*), and 'Thomas' (*△*) and of *J. hindsii* (*▲*), all with roots waterlogged at 23°C.
Among all treatments, the times at which individual plants showed symptoms ranged from six to more than 22 days. Plants removed from treatment with symptoms of root damage as expressed by leaves did not recover during six weeks of subsequent observation in the greenhouse. Irreversible damage to the root systems had occurred (4).

Only small differences in the pattern of survival appeared between any two lots of seedlings in any of the comparisons. Therefore, the time of appearance of symptoms for each seed source for all trials was averaged (Fig. 1). The total numbers of plants for each seed source were as follows: 'Ohio', 60; 'Thomas', 100; Tennessee clone, 80; and J. hindsii, 80. Variability among seedlings in each experiment and the nature of the resultant survival curves were similar to those found in previous studies with Juglans (4) and Prunus (16).

Survival curves in Fig. 1 do not reach 0% because plants without symptoms of damage from waterlogging were drained when about 80% of the plants in each batch had been affected. These 'survivors' were viewed as superior phenotypes with potential for use in rootstock improvement efforts. Some root damage had occurred with these plants but not to the extent of that in the nonsurvivors. Prolonging treatments for one to a few days beyond the times imposed would have given 0% survival (unpublished data). About 60% recovered and were later planted. Results were similar to those in a previous study with Juglans (4).

The survival data fit a logistic survival model (7), and slope and intercept values were obtained for each lot of seedlings. A one-way analysis of variance comparing mean slopes and intercepts for all combinations using the Bonferroni correction analysis by example. 1st ed. Wiley, New York.


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