Apparent freeze damage to black walnut seedlings related to seed source and fertilizer treatment

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Following exposure to 15°F temperature in early November 1971 in a southern Indiana nursery, many walnut seedlings were top-killed. Trees of Kentucky, Tennessee, and Alabama origin suffered about four times as much damage as Michigan trees. Seedlings fertilized with ammonium-type fertilizers were less severely affected than unfertilized seedlings or those treated with sodium nitrate. More than 60 percent of the injured seedlings died during the first growing season after outplanting.

In March 1972. the stems of many black walnut seedlings from seedbeds at the Indiana Division of Forestry Nursery near Vallonia, in southern Indiana. were black and apparently dead. However. the root systems of the top-killed seedlings appeared to be alive and healthy. Cultures taken from injured seedlings revealed that the injury was not pathogenic, so it was concluded that the seedlings were probably damaged by unique weather conditions.'

The fall of 1971 was unusually warm, but there was a sharp temperature drop from 64° to 15°F within 1-1/2 days in early November. We theorized, therefore, that the warm fall kept the stems active and succulent, and physiologically unable to withstand the sudden drop in temperature.

Winter injury of black walnut in the nursery apparently is unusual. This was the first major occurrence reported in 12 years of close contact with midwestern nurserymen. In our research on black walnut, only one other example of autumn freeze damage has been observed: two Tennessee seedlots grown in a northern Indiana nursery suffered dieback during the winter of 1963-64. In the only published reference to such freeze damage that we have seen. young black walnut trees from Virginia. Tennessee, Oklahoma, and farther south suffered winter dieback for 6 consecutive years in plantings at Lincoln, Neb. In contrast, trees from Nebraska and South Dakota were not damaged at all.'

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4 Cultures were made by Dr. Frederick H. Berry, Principal Plant Pathologist, Northeastern Forest Experiment Station. Delaware. Ohio. April 7. 1972.

5 R. A. Emerson. The relation of early maturity to hardiness in trees. Nebr. Agric. Exp. Stn. Annu. Rep. 19: 101.110. illus. 1906.

The Vallonia nursery is situated on a nearly level, well drained alluvial soil with a good windbreak system. The windbreaks restrict air drainage to some extent, but there is no evidence of. major frost pockets. Recommended nursery management practices are followed carefully, and irrigation is discontinued by midAugust to allow the seedlings to harden off.

Effect of Geographic Origin

One of the freeze-affected beds at the Vallonia Nursery contained walnut seedlings from Michigan, southern Illinois, Kentucky. Tennessee. and northern Alabama seed sources. Plots had been thinned in early June 1971 to 4. 8, and 16 seedlings per square foot (for a seedbed density study). but by the end of the growing season natural mortality had reduced densities to about 3. 6, and 9 per square foot overall. and somewhat less for seedlings of Alabama origin. Seedlings were dug in November, just a few days after the low temperatures were recorded on November 7 and 8. and immediately placed in cold storage. In early December. when the seedlings were sorted for planting, they appeared normal. But when they were unpacked for planting in the spring. the black stems were noticed. Nevertheless, the injured trees were planted because replacements were no longer available.

Analysis revealed that latitude of the seed source accounted for 76 per

cent of the variation in incidence of injury, which was about four times as frequent for the three southern seed sources as for the Michigan source (fig. 1).

Frequency of top-killed seedlings was 20. 26. and 17 percent, respectively. for the planned densities of 4, 8. and 16 seedlings per square foot. These differences are statistically significant, but we cannot explain why damage was greatest in the medium-density plots. Seedling size had little effect on amount of damage although large seedlings tended to be slightly less damaged.

After the first growing season in the field it was clear that injured trees were poor risks as planting stock. Sixty-one percent of the blackstemnined seedlings died, regardless of seed source (fig. I). Moreover. mortality of the top-killed seedlings among seed sources followed a similar pattern in Michigan, Indiana, and Tennessee outplantings.

Effect of Fertilization

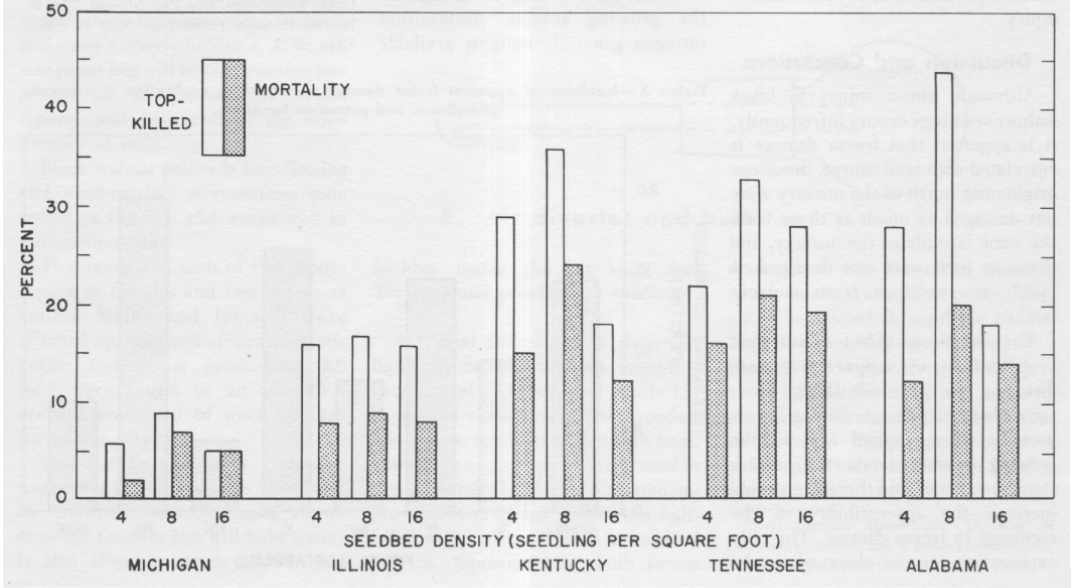
In another study at the same nursery, walnut seedlings from an Indiana seed source were damaged. The study compared four nitrogenous fertilizers, each applied in the spring of 1971 at a rate equivalent to 150 pounds of N per acre. The plots had received an application of a complete balanced fertilizer the previous fall. In these plots, the amount of top-kill was related to the type of fertilizer applied (fig. 2).

Generally. seedlings fertilized with ammonium sulfate and ammonium nitrate were less severely affected than unfertilized seedlings or those fertilized with sodium nitrate. Intermediate in incidence of damage were seedlings in plots fertilized with urea, which hydrolyzes into arm monism. The seedlings fertilized with ammonium sulfate grew fastest and those fertilized with sodium nitrate grew slowest.

During the winter of 1972-73. another incidence of cold-weather in jury was noted at the Vallonia Nursery in seedbeds treated with various combinations of nitrogen, phosphorus. and potassium fertilizers. These fertilizers were applied August 16, 1972. at rates of 120. 50, and 100 pounds of N. P. and K per acre, respectively. Nitrogen was applied as ammonium nitrate (33-0-0). phosphorus as superphosphate (0-46-0), and potassium as muriate of potash (0-0-60). The fall of 1972 was also warns with 65^0 to 75°F maximum temperatures recorded until midOctober. when a sudden cold snap dropped night temperatures to the low 20Is. When the seedlings were lifted in March 1973. almost 15 percent of the unfertilized seedlings had dead or injured stems (fig. 3).

Nitrogen fertilization significantly reduced the severity of the freeze damage. Seedlings fertilized with phosphorus and potassium were slightly more severely damaged than the unfertilized seedlings, but the

Figure 1.—Top-kill in the nursery and mortality after 1 year in the field apparently caused by freeze damage to walnut seedlings, by seed source and seedbed density.



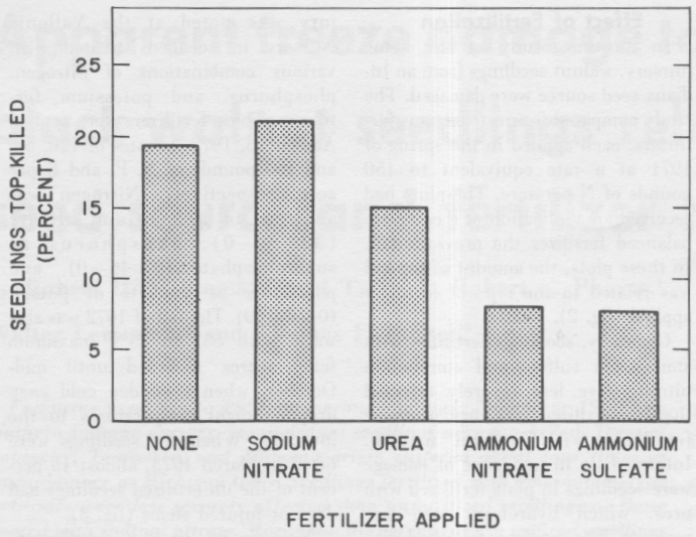


Figure 2.—Incidence of apparent freeze damage as related to type of nitrogenous fertilizer applied.

differences were not statistically significant. These results tended to confirm results of the previous year that nitrogen fertilization, especially when applied in the ammonium form, reduces the incidence of cold-weather injury.

Discussion and Conclusions

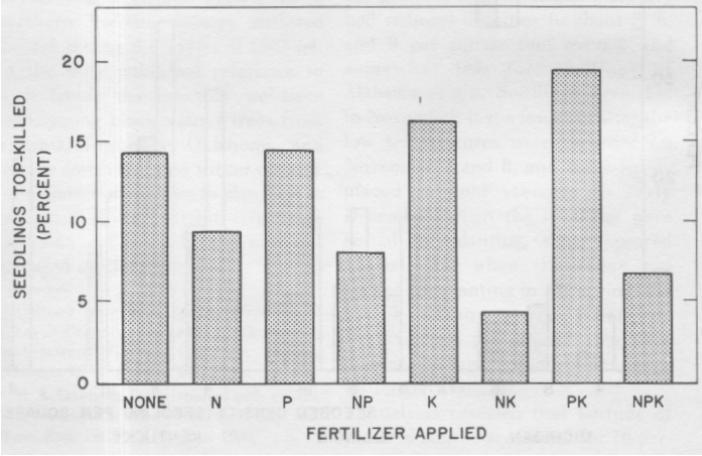
Although winter injury to black walnut seedlings occurs infrequently, it is apparent that freeze damage is correlated with seed source. Seedlings originating north of the nursery were not damaged as much as those from the same latitude as the nursery, and these in turn were not damaged as much as seedlings from sources farther south.

The inhibitory effect of nitrogen fertilization on apparent freeze damage to the seedlings was somewhat surprising. Nitrogen, especially when applied late in the growing season, tends to increase stem succulency and therefore should increase the susceptibility of the seedlings to freeze damage. The only explanation for the observed results was that nitrogen fertilization improved internal nutrient balance and increased the vigor of the seedlings. The soils of the nursery are sandy, and therefore are probably unable to hold adequate nitrogen throughout the growing season. Ammonium nitrogen generally remains available longer into the growing season and is absorbed more easily by the seedlings than nitrate nitrogen. Fertilization, especially with ammonium nitrogen. may offer a practical means of reducing the risk of cold damage to walnut seedlings to be held overwinter in the seedbeds.

Even though apparent freeze damage has occurred at the Vallonia Nursery for two consecutive years, we do not believe there is any great risk from freezing temperatures even when seedlings are grown from seed sources far south of the nursery. This is important in light of the current recommendation to plant seedlings from seed sources up to 150 miles south of the planting site.[6]

When seed is scarce or expensive. however. the risk may be minimized by sowing the seed in nurseries south of its source, by lifting seedlings as early as possible in the autumn and holding them overwinter in cold storage, or by using appropriate fertilizers.

Figure 3 —Incidence of apparent freeze damage as related to application of nitrogen, phosphorus, and potassium fertilizers.



6- Calvin F. Bey. Growth of black walnut trees in eight Midwestern States—a provenance test, USDA Forest Serv. Res. Pap. NC-91, 7 p., illus. North Cent. Forest Exp. Stn., St. Paul, Minn. 1973.