Application of Nitrogen Fertilizer to Control Anthracnose of Black Walnut

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ABSTRACT

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Nitrogen fertilizers enhanced the resistance of *Juglans nigra* to walnut anthracnose incited by *Gnomonia leptostyla* and delayed premature defoliation. Application rates were directly correlated with foliar color and tree growth and inversely correlated with disease severity. Ammonium sulfate, ammonium nitrate, and urea were equally efficient sources of nitrogen. Both April and June applications of nitrogen were effective. The addition of phosphorus and potassium often diminished the effectiveness of nitrogen.

Black walnut, *Juglans nigra* L., is frequently prematurely defoliated in August or September by the fungus *Gnomonia leptostyla* (Fr.) Ces. & de N. The disease can be controlled with applications of a protectant fungicide (3), but control measures are being sought that will limit or reduce the use of pesticides (2). Investigations conducted between 1973 and 1977 indicated that the use of nitrogen fertilizers in walnut plantations reduced the August incidence of diseased leaflets by 46% and September defoliation by 61% (1). The validity of these preliminary findings was tested intensively in 1978 and 1979 in experiments that are discussed in this paper.

MATERIALS AND METHODS

Black walnut trees in three U.S. Forest Service plantations at Carbondale and Cadiz in southern Illinois were treated with nitrogen in 1978 and 1979. The Carbondale plantation was planted in 1966 in rows 6 m apart with seedlings 3 m apart in the row. The trees near Cadiz were planted in 1970 in rows 3 m apart, with 3 m between trees in the south plot and 1.5 m between trees in the north plot.

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Specimen trees within the plots were selected in the fall of 1977; a point 3-m high on each trunk was marked with paint, and tree diameters were measured with a steel tape.

Replicated tests were established on the effects of nutrient source and the rate and time of application. The nitrogen sources were ammonium nitrate, ammonium sulfate, and urea. The phosphorus source was superphosphate, and the potassium source was muriate of potash. Nitrogen (N) alone and nitrogen, phosphorus, and potassium combinations (NPK, NP, NK, PK) were compared at the uniform rate of 29 g of nitrogen per square meter (6 lb/1,000 ft) in the spring. Ammonium nitrate was also applied at half and twice that rate in the spring and at the uniform rate in the summer. These nutrient treatments were broadcast on the soil surface. Urea was applied to the foliage to runoff with a knapsack air compression sprayer each year in mid-May, early June, and late June.

In 1978 and 1979, the randomly selected trees were divided into 12 treatment groups at each site (Table 1). One-tree plots were replicated six times at Carbondale (9 m^2/tree) and five times at Cadiz south (3.5 m^2/tree). At Cadiz north, three-tree plots (17 m^2) were replicated four times. Nine soil treatments were applied on 18–19 April 1978 and again on 22–23 March 1979. One soil treatment was applied 15 June 1978 and again on 23 June 1979. One group of trees received only the foliar sprays, and

Table 1. Effects of nutrients applied to black walnut trees in southern Illinois in 1978 and 1979[v]

Treatment	Rate (g/m^2)	Disease severity[w]	Color rating[x]	Diametric growth (mm)
None		44.0 ab[y]	3.1 a	4.3 a
Urea (foliar)[z]		44.7 a	3.3 ab	4.8 ab
PK	29	41.5 b	3.3 ab	4.5 a
NPK	29	36.8 c	3.6 bcd	6.1 cde
NH_4NO_3	14.5	35.2 c	3.5 bc	5.0 ab
NK	29	34.3 cd	3.9 de	6.7 e
NH_4NO_3	29	34.2 cd	3.7 cd	6.5 de
NP	29	33.7 cd	3.8 cde	5.4 bc
NH_4NO_3	29	31.1 de	3.9 de	6.0 cde
$(NH_4)_2SO_4$	29	30.8 de	3.7 cd	5.8 cd
Urea	29	28.8 e	3.7 cd	6.3 de
NH_4NO_3	58	21.3 f	4.1 e	7.7 f

[v] Data represent the averages of six trials (three sites for 2 years).
[w] Percentage of leaflets with one or more lesions.
[x] 1 = yellow green, 3 = average green, 5 = dark green.
[y] Letters indicate Duncan's multiple range groupings, which do not differ significantly at the 0.05 level.
[z] Three foliar applications sprayed to runoff at 10 g/L.

another was untreated.

Three rating systems, pertaining to tree growth, foliar color, and disease severity, were used to determine the effect of nutrients on walnut trees. Trunk diameters were measured 19 September 1978 and 26 September 1979. Average foliar color of each tree was rated on a scale of 1 to 5 (1 = yellow green, 3 = average green, 5 = dark green) on 5 June 1978 and 23 June 1979. Disease severity was rated in terms of the percentage of leaflets having one or more anthracnose lesion after examination of each tree on 22 August 1978 and 24 July 1979.

RESULTS

Black walnut trees treated with nitrogen fertilizers grew more, were darker green in color, and had less anthracnose. These responses were directly related to the rate of fertilizer application (Table 1). Responses to nitrogen source materials (ammonium nitrate, ammonium sulfate, and urea) applied in early spring at the uniform rate were not statistically different. The nitrogen treatments at half, once, and twice the uniform rate increased tree growth by 16, 40, and 79%, respectively, when compared with the control. The 3.1 color rating on untreated trees was substantially lower than the 3.5, 3.8, and 4.1 ratings that followed increasingly heavier nitrogen applications. Disease control increased by 20, 31, and 52%, respectively, when compared with untreated plants.

Ammonium nitrate applied in June gave essentially the same results as when applied earlier in the season. Foliar treatment with urea did not produce statistically better results than no treatment. Disease severity ratings taken later in the season (data not shown) indicate that nitrogen applications were less effective in controlling late-season infections.

Phosphorus and potassium fertilizers applied without nitrogen did not enhance disease control, foliar color, or tree growth. When used with nitrogen, they produced no better results than nitrogen alone, and they often reduced the coloration, growth, and disease-control improvements resulting from the use of nitrogen.

Color rating and diametric growth were directly correlated (coefficient, 0.894); both were inversely correlated with disease severity (color coefficient −0.892, growth coefficient −0.852).

DISCUSSION

Producers want to control anthracnose, especially in plantations of young black walnut trees. Benomyl sprays can achieve about 90% control, but two properly timed applications are required (2). The economic benefits of fungicide spray applications are yet to be established.

Integrated pest management includes the use of procedures other than pesticides for controlling plant disease. These field experiments demonstrated that cultural practices can reduce walnut anthracnose severity. As many as 50% fewer leaflets were infected in midseason on trees receiving nitrogen fertilization. This treatment delayed leaf maturity and at the same time delayed infection or lesion development. Nitrogen fertilization also stimulated the growth of young plantation trees, which is a benefit of economic importance.

LITERATURE CITED

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