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Nitric Acid Promotes Pine Seed Germination

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SUMMARY

Germination of a number of recalcitrant seed lots of loblolly, slash and longleaf pine was improved markedly following treatment with 0.1 percent nitric acid for 4 hours or 10 percent for 10 minutes.

Additional keywords: Sexual propagation, progeny testing, growth promoters.

INTRODUCTION

Slash *(Pinus elliottii* Engelm. var. *elliottii)*, longleaf (*P. palustris* Mill.), and loblolly (*P. taeda* L.) pine seeds generally germinate satisfactorily following 4°C storage for 5 years or more (Schopmeyer 1974). However, specific lots may be difficult to germinate even when stratified. Although the seeds appear sound when cut and examined, some type of induced dormancy exists. A simple chemical method for breaking dormancy of difficult-to-germinate seed lots would be valuable in tree improvement operations such as progeny testing. Biswas et al. (1972) reported that potassium nitrate, gibberellic acid, kinetin, and thiourea promoted loblolly pine seed germination. These chemicals and benzyladenine, hydrogen peroxide, boric acid, citric acid, and nitric acid were applied to break dormancy, but in the present trials only HNO_3 consistently promoted germination. This paper reports a series of experiments in which pine seed germination was improved following treatment with nitric acid.

MATERIALS AND METHODS

Unstratified seed lots of different ages and families were treated with HNO_3 in 1980 and 1981. Most lots had a history of poor germination following an overnight water soak. Longleaf, loblolly, and slash were tested separately. Typically, 40 to 75 seeds per treatment were placed in a 125 ml Erlenmeyer flask containing 40 ml water (control) or the appropriate chemical solution. The flasks were gently shaken for the specified length of time, the solutions were decanted, and the seeds rinsed with water. Seeds were sown, without drying, on moistened vermiculite and germinated in the greenhouse under intermittent mist or in a closed container in the growth chamber (30° C, 16-hour day, 20° C night). To see whether the nitric acid effect was due to the H^+ ion or the NO_3^- ion, the effects of water, HNO_3, H_2SO_4, and KNO_3 on seed germination were compared. "Percent HNO_3" in this instance, refers to the percent of concentrated stock nitric acid used (70 percent HNO_3 in H_20 v/v).

RESULTS AND DISCUSSION

Nitric acid improved both the rate of seed germination and the total germination of many family and bulk seed lots of slash, loblolly, and longleaf pine (tables 1 and 2), but a few lots still germinated unsatisfactorily following HNO_3 treatment. Poor germination of seed lots was related both to age of seed within a family (table 1) and to specific families where age was not a factor (table 2). In Trial 5 with slash pine family 18–27, 23-year-old seed germinated poorly even with HNO_3, and germination of controls, as well as response to HNO_3 treatment, improved as time in storage decreased. Overall, slash and loblolly pine seed germination was doubled by HNO_3 in the 18-day trial. With longleaf pine, a 10-minute soak in 10 percent HNO_3 improved germination of 12 recalcitrant seed lots (table 2). Overall germination was increased fivefold at 10 days (not shown in table) and threefold at 20 days.

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Table 1.—*Percent germination of loblolly and slash pine seed, with and without 0.1 percent nitric acid treatment*

Species	Trial number	Family	Collection year	Soak	Days after treatment 10 H_2O	10 HNO_3	18 H_2O	18 HNO_3
				hours	*percent*			
Loblolly	4	Bulk	1968	4	5	20	35	60
Slash	1	Bulk	1972	4	56	80	.....	.....
	2	18-27 × wind	1978	4	15	70	45	80
	3	18-27 × wind	1978	4	5	45	60	85
	4	18-27 × wind	1977	4	0	37	12	65
		18-27 × wind	1977	20	0	53	12	80
	5	18-27 × wind	1957	4	0	0	8	15
		18-27 × wind	1957	16	0	8	8	28
		18-27 × wind	1967	4	3	5	32	45
		18-27 × wind	1972	4	8	25	37	62
		18-27 × wind	1978	4	3	33	42	72
	6	18-27 × wind	1979	24	41	84	54	86
		W-1-20 × wind	1979	24	44	78	73	79
		W-1-20 × W-1-5	1979	24	.....	.....	46	79
		18-27 × 9-2	1979	24	70	91	81	95
		18-27 × BC-1	1979	24	75	90	84	92
		18-27 × BC-2	1979	24	60	85	71	87
Mean					24	51	42	67

Table 2.—*Percent germination after 20 days with difficult-to-germinate seed lots of longleaf pine treated with water or 10 percent nitric acid 10 minutes. Seed collected in 1979 and 1980*

Family	H_20	HNO_3
35	11	16
A-1	11	58
A-4	2	16
A-10	6	60
A-12	8	70
A-15	9	20
B-5	9	22
B-9	15	66
B-10	2	16
B-11	6	8
B-13	16	26
B-17	10	40
Mean	8.8	34.8

Generally, 0.1 percent HNO_3 for 4 hours was effective, but a 16- or 20- hour soak was sometimes better with 0.1 percent HNO_3 (table 1). Apparently the effect is dose-specific; in another trial with longleaf pine 0.1 percent for 1,000 minutes, 1 percent for 100 minutes, and 10 percent for 10 minutes were equivalent. Germination at 18 days was 55, 60, and 60 percent respectively for the three HNO_3 treatments, compared to only 5 percent with water.

Efforts to determine whether the mechanism of HNO_3 stimulation is a hydrogen ion or a nitrate effect were unsuccessful. While HNO_3 improved germination of slash pine seed, equimolar concentrations of H_2SO_4, KNO_3, and H_2SO_4 + KNO_3 inhibited germination.

Although pine seed germination is generally not a problem, poor germination can seriously hamper progeny testing operations of certain lots. To avoid such problems, soaking southern pine seeds for 10 minutes in 10 percent HNO_3 followed by a water rinse may be helpful.

LITERATURE CITED

Biswas, P. K.; Bonamy, P. A.; Paul, K. B. Germination promotion of loblolly pine and baldcypress seeds by stratification and chemical treatments. Physiol. Plant. 27:71–76; 1972.

Schopmeyer, C. S. Seeds of woody plants in the United States. C.S. Schopmeyer, Technical Coordinator. Agric. Handbook No. 450. Washington, DC: U.S. Department of Agriculture Forest Service; 1974. 883 p.

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