GREEN MANURE OF SORGHUM-SUDAN: ITS TOXICITY TO PINE SEEDLINGS[1]

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In recent years, green manuring with sorghum-Sudan, or Hyden grass, has become considerably more popular among some nursery workers. In part, the use of these rapidly growing annuals was stimulated by the assumption that the toxic excretions of these plants, or their residues, would control Cylindrocladium floridanum and other root rot fungi. The phytotoxicity of either component of these hybrids, which contain hydrdcyanic acid, is well established. In time of drought, Sudan pastures have been responsible for the mortality of livestock (*3*). On the other hand, sorghum residues contain highly concentrated phytotoxins, which inhibit the growth of crops even after 16 weeks of decomposition (*1, 2*). These observations suggest that green manure of sorghum-Sudan may unfavorably influence the growth of nursery stock. In consequence, a study of the effect of sorghum-Sudan on seedlings of several pine species was conducted under controlled conditions.

Methods and Materials

Beginning in the middle of May 1976, two crops of sorghum-Sudan were raised in half-gallon glazed pots containing A-1 horizon of Plainfield sand. After 5 weeks of growth, the tissues of each successive crop were cut in approximately 1-inch segments and incorporated into the soil. Two weeks after incorporation of the second crop, in late August, the green-manured and untreated soils were sown to red, *Pinus resinosa*, white, *P. strobus*, and Monterey, *P. radiata* pines. The seedlings were harvested in the middle of December.

All trees raised in soils treated with sorghum-Sudan suffered more than 50 percent mortality. The surviving 10-week-old seedlings were of greatly reduced size and drastically abbreviated root systems (table 1). Roots of some seedlings, especially those of white pine, exhibited severe injury (fig. 1), resembling "burning" produced by lead arsenate (*4*).

Following the removal of seedlings, the same soils were sown to red and Monterey pines in the hope that detoxification during the preceding period had reduced the harmful effects of the incorporated tissues. This trial was discontinued in April, when the seedlings were 3 months old. The growth of trees indicated that a detoxification period of 4 winter months alleviated the toxicity only minimally. The growth of both red and Monterey pines in green-manured cultures was still drastically suppressed (fig. 2). The large volume of sorghum-Sudan tissue provided by the two crops undoubtedly was a contributing factor.

In mid-April 1977, the trials were repeated under conditions that considerably reduced the effect of toxic substances by using a single crop of the Hyden grass and a prolonged preseeding period of detoxification at high temperature, with an adequate moisture supply. The growing media consisted of soils collected from the Griffith, Hayward, and

Table 1.—*Effect of sorghum-Sudan green manure on the growth of 10-week-old pine seedlings. (ovendry weight of average plants).*[1]

Tree species	Control soils		Sorghum-Sudan-manured soils	
	Weight of seedlings	Length of roots	Weight of seedlings	Length of roots
	g	*cm*	*g*	*cm*
White pine	0.045	5.7	0.011	0.9
Red pine	0.120	7.3	0.036	2.4
Monterey pine	0.470	5.8	0.175	1.6

[1]Seeds were planted 2 weeks after incorporation of the second green manure crop.

[1]Research was supported by the College of Agricultural and Life Sciences, University of Wisconsin at Madison, and the Wisconsin Department of Natural Resources.

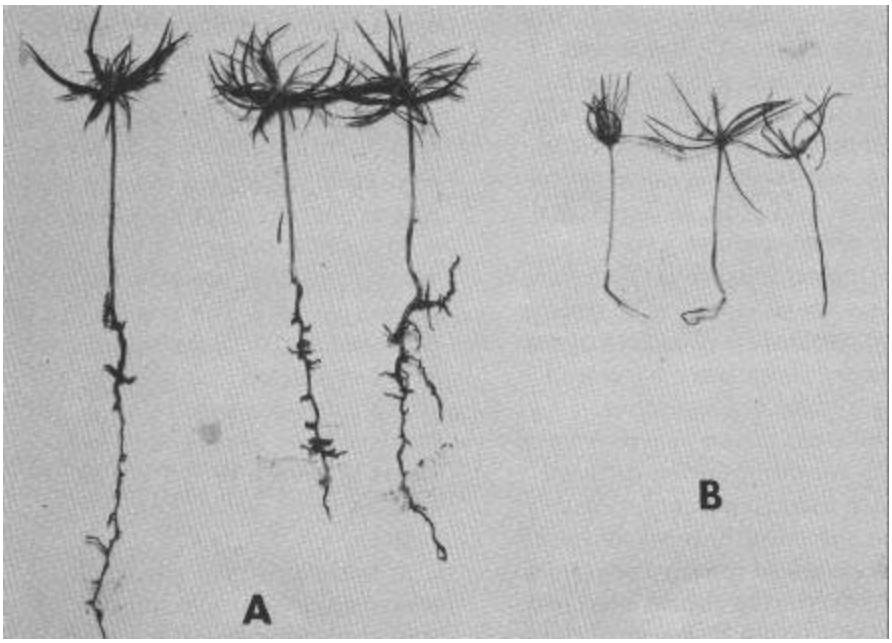

Figure 1.—*Effect* of *sorghum-Sudan green manure on the development* of *9-week-old white pine seedlings. Seedlings labeled "A" are normally developed and were raised in untreated sandy soil. Seedlings labeled "B" were raised in a similar soil treated with two crops* of *sorghum-Sudan green manure. Seeds were planted 2 weeks after incorporation of the second green manure crop.*

Wilson State nurseries of Wisconsin. The soils were placed in half-gallon jars, using six jars for each nursery soil. Half of these were sown to Hyden grass and half were left untreated. Early in June, the green manure was incorporated into the soils on which the Hyden grass was grown and allowed to incubate in the greenhouse for 90 days. Both green-manured and control soils were kept at an approximate moisture content of 8 percent by weight. In early September, all soils were planted in red pine; using 15 seeds per container. One month later, the cultures were thinned to 10 trees per jar. The trees were harvested on March 20, 1978.

The results, given in table 2, show that even a prolonged detoxification period following incorporation of a single crop of sorghum-Sudan hybrids failed to entirely eliminate the depressing effect on the growth of tree seedlings. This green manure exerted a particularly unfavorable influence on the development of root systems, which were completely devoid of mycorrhizal short roots. These effects were recorded on all soils despite the considerable difference in fertility of the three nursery soils, as expressed by the weight of the trees produced in control cultures.

Conclusions

These trials demonstrated that, under certain conditions, green manure of sorghum-Sudan hybrids can inflict severe damage on young nursery stock, in large part by eradication of nutritionally essential mycorrhiza-forming fungi. The phytotoxicity of this green manure is directly related to its biomass and indirectly to the length and conditions of the preseeding period of detoxification. As suggested by our trials, the negative effect of sorghum-Sudan grass may be partly alleviated by early plowing of the green manure and late fall seeding of the nursery crop. A reasonably heavy periodic watering is likely to promote the gravitational discharge of toxic compounds. However, even these measures may not entirely eliminate the negative effects of the grass. This is especially true under present conditions of nursery soil management involving the use of potent eradicants, because the primary purpose of green manure is to provide sustenance and energy material for biodegrading soil organisms. If the life-promoting green manure is replaced by one with biocidic

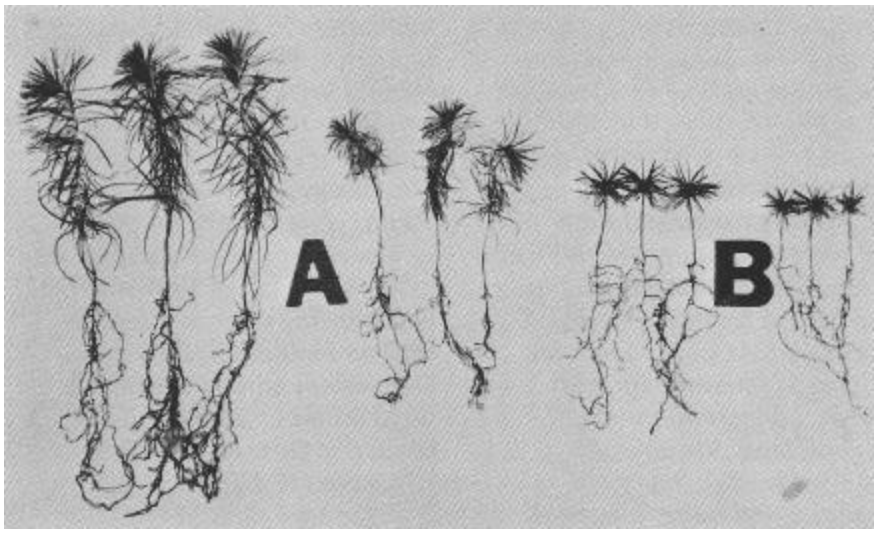

Figure 2.—*Normal and depressed developments of 3-month-old Monterey pine (A) and red pine (B) raised in control and sorghum-Sudan green-manured soils following detoxification during 4 winter months.*

properties, the end result will undoubtedly be additional deterioration of the soil productive capacity, and a subsequent decrease in the survival of outplanted nursery stock.

Table 2—*Effect of sorghum-Sudan green manure on the growth of 6-month-old seedlings of red pine,* Pinus resinosa.[1]

Origin of soils	Treatment	Weight of avg. plant	Weight of avg. crown	Weight of avg. root	Top-root ratio
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Griffith nursery	Control	556	403	153	2.63
	Hyden manure	334	187	147	1.27
Hayward nursery	Control	390	267	123	2.17
	Hyden manure	274	181	93	1.94
Wilson nursery	Control	740	473	267	1.77
	Hyden manure	451	324	127	2.55

[1]Seeds were planted following a detoxification period of 3 summer months.

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