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DEVICES TO PROTECT SEEDLINGS FROM DEER BROWSING

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Abstract.—Studies on the Allegheny Plateau of Pennsylvania have shown that several types of wire or plastic tubes can be erected around tree seedlings to protect them from deer browsing. The two most promising devices are a 4- to 6-inch diameter plastic tube with small mesh and a 12-inch diameter tube constructed of chicken wire. Both types need to be at least 5 feet tall to provide adequate protection in areas of heavy browsing pressure. The plastic protectors are more expensive than those made of wire, but are somewhat quicker to fabricate, and they offer the added advantage of protection against rodents.

Severe browsing of tree seedlings by white-tailed deer has resulted in complete regeneration failures in many sections of Pennsylvania, and planting of areas that fail to regenerate naturally is futile unless the planted seedlings are protected against browsing. One promising way to protect both natural and planted seedlings is to place plastic or wire-mesh tubes around the seedlings to protect their terminal leaders until they grow above the reach of deer.

Trials of various types of individual protection devices conducted over the past 5 years have shown that cost and effectiveness vary greatly. This report describes the results obtained with various devices and makes recommendations on their use.

Study Methods

In May 1972, two recently clearcut areas on the Allegheny National Forest in northwestern Pennsylvania were selected for an experiment to compare seven different types of protective devices. Both areas contained natural seedlings that were being browsed.

The seven devices studied were as follows:

1. A cattle-wire mesh tube, 3 feet in diameter and 5 feet tall, held in place around the seedling by three wooden stakes. The openings in this wire varied from 2 by 6 inches at the bottom to 4 by 6 inches at the top.

2. Same as 1 above but 1 foot in diameter and supported with two rather than three wooden stakes.
3. Same as 2 above, but made of 2-inch chicken-wire mesh rather than cattle-wire.
4. A large mesh white plastic tube 1 foot in diameter, 5 feet tall, and supported by two wooden stakes. The mesh in this device was diamond-shaped, with openings about 1 inch high by 1/2 inch wide.
5. A green plastic tube with mesh similar to item 4 above, but only 2 inches in diamter.
6. A 3-inch diameter yellow plastic tube with small (3/8-inch square) mesh, 5 feet tall.
7. A single wooden stake, erected without any sort of plastic or wire tube. The stake was 5 feet tall, and the terminal shoot of the seedling was tied to the stake with a piece of string.

Sixteen groups of seedlings were selected in each of the two clearcut areas. All seedlings within each group were similar in height, and the individual devices were assigned at random within each group. In addition to the seven different protective devices, each group contained a control or unprotected seedling.

Thermocouples were attached to a few sample seedlings in treatments 5, 6, and 7 so that temperature measurements could be taken. Measurements of light quantity and spectral distribution inside each of the tubes were made with an ISCO spectralradiometer.

Seedling height, incidence of deer browsing, and condition of the protective device were observed each spring and fall in 1972 and 1973, then again in the spring of 1976. Analyses of variance were run to test differences among treatments in height growth and percent of browsing.

Beginning in 1974, seedlings in additional clearcuts on the Allegheny National Forest were protected, using yellow plastic tubes similar to those described for treatment 6 above, but 6 inches in diameter. Both 4-foot and 5-foot-tall tubes were used, and a variety of supporting stakes were tried. These included steel reinforcing rods, fiberglas rods, and reject wooden tool handles from a local ash handle factory. In some cases, two stakes were applied to each tube, and the tube was attached with soft wire or hog rings. In other cases, a single stake was used, with several wood pieces attached to the stake to keep the tube spread open.

The tubes applied since 1974 have not been part of a formal experiment, but represent administrative trials of the devices. Observations of seedling growth and device condition were made in August 1976, but no attempt was made to tally all devices in use.

In the spring of 1975, additional chicken-wire protectors identical to those for treatment 3 above were erected as part of a planting experiment on the Tuscarora State Forest near Mifflintown, Pa. In that experiment, seedlings of several species were planted in rows under various stand conditions. Seedlings in half of the rows were fitted with protectors, and half were unprotected. Measurements of seedling growth, incidence of browsing, and condition of the devices were made three times during each of the 1975 and 1976 growing seasons.

Results

Effectiveness against browsing.—The effectiveness of the tube-like protective devices was a function of both the diameter and the mesh of the plastic or wire material (table 1). Deer were able to reach through the very large mesh of the cattle-wire protectors to browse on the seedlings inside. As a result, these protectors were not effective unless they were of such large diameter (3 feet) that deer could not reach the seedling in the center. Almost all seedlings in the 1-foot-diameter cattle-wire protectors were browsed during the first year of the study. However, the smaller mesh of the chicken wire or plastic protectors was fully effective when used in the 1-foot diameter.

Table 1.—Proportion of terminals browsed during first two growing seasons

Protective device	Terminals browsed
	Percent [a]
1-foot chicken wire	0a
1-foot white plastic	0a
3-foot cattle wire	6a
3-inch yellow plastic	6a
2-inch green plastic	50b
Wooden stake	81c
1-foot cattle wire	94c
Control	94c

[a] Values with same subscript are not significantly different at 0.05 level.

In the smaller diameters, even the medium-size mesh of the green plastic protectors was too open to afford protection. The terminals of many seedlings simply grew out through the side of these 2-inch tubes (fig. 1). Of the small-diameter tubes, only the extremely small mesh of the yellow plastic tubes proved small enough to keep the seedlings inside where they could not be reached by deer.

The wooden stake alone offered very little protection from browsing. Although the terminals had been tied close to the stake initially, they quickly grew out away from the stake to where they could be nipped.

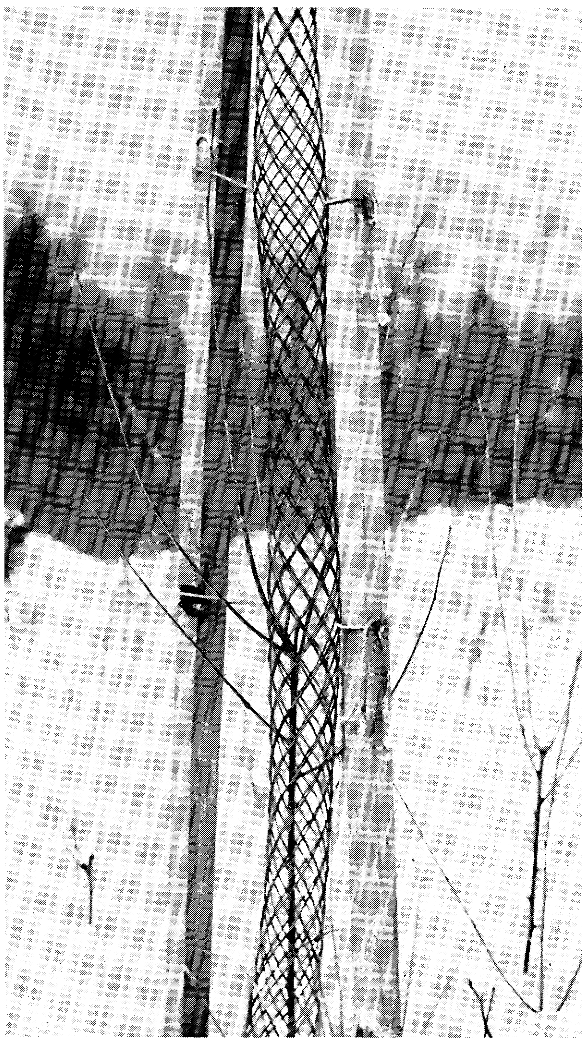
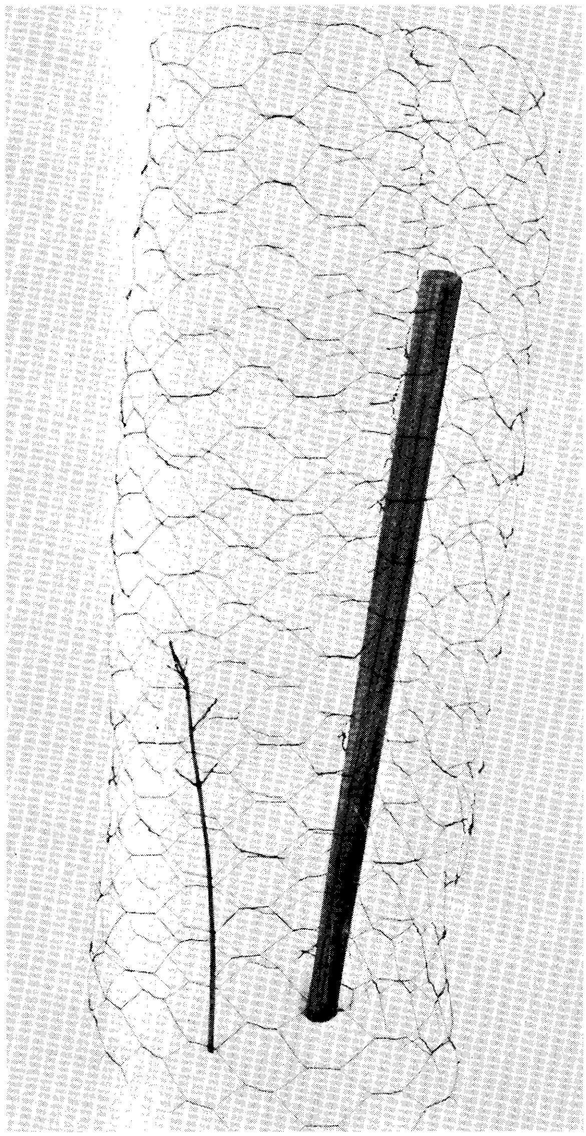


Figure 1.—A seedling growing out through the sides of a large-mesh, small tube is vulnerable to deer browsing.

Figure 2.—A chicken-wire tube used to protect planted seedlings.



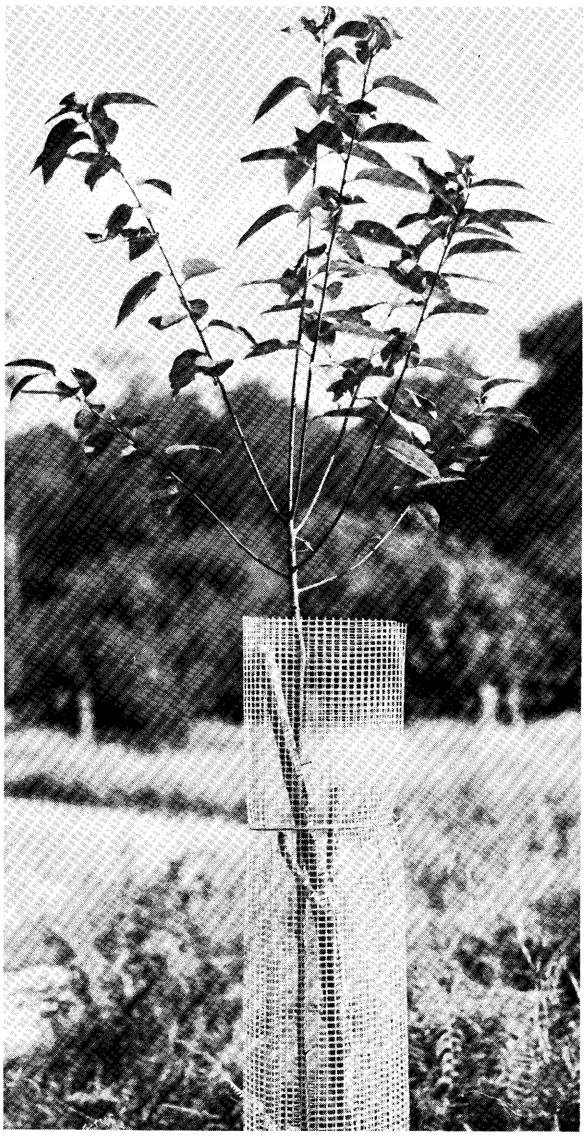
The chicken wire and yellow plastic devices used in later trials have been more than 90 percent effective, and only an occasional terminal was nipped when it grew out the side of the protector (fig. 2). When this occurred, a new shoot invariably formed inside the device to replace the one lost, so that a protected seedling remains in spite of the one browsing incident.

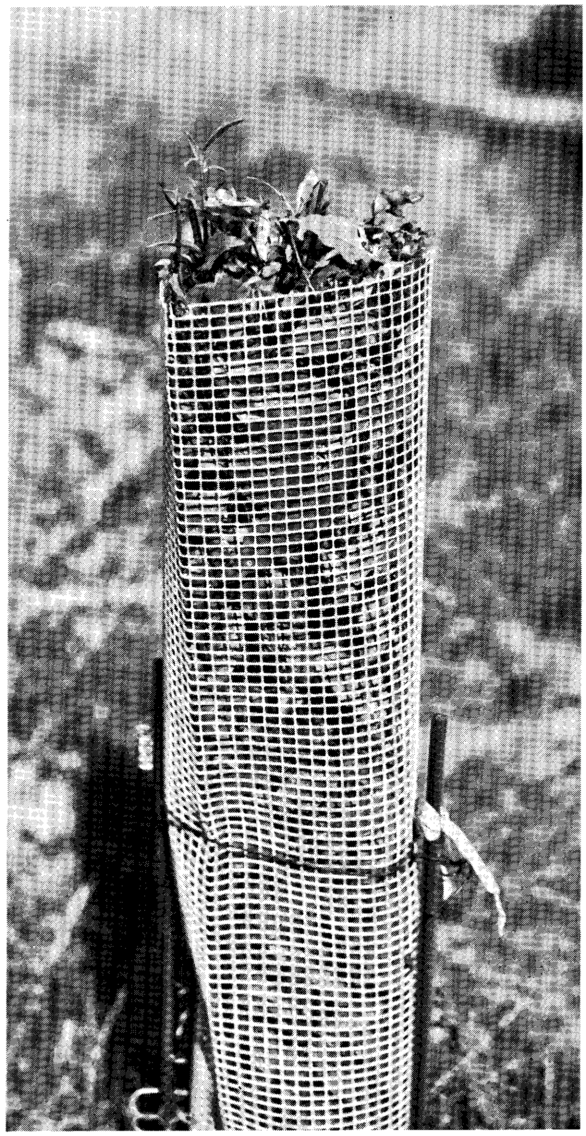
Physical condition and durability of devices.—The wire-mesh protectors suffered little damage during the 5-year study period, although a few fell over because the wooden support stakes had rotted at the ground level. But the wire itself remained effective as long as the stakes were in place.

The first plastic protectors used were not nearly as durable as the wire; they were constructed of different plastic materials. The white plastic became very brittle and shattered easily when cold. This material had completely disintegrated by the start of the third growing season. The yellow plastic began disintegrating after the third growing season, and was nearly all gone after the fourth year. The green plastic remained intact after 5 years.

After consultation with the manufacturers of

Figure 3.—Small-mesh yellow plastic tubes protecting black cherry seedlings from deer browsing. The seedling on the left has grown out the top of the 5-foot tall protector and is now beyond the reach of deer. The seedling in the shorter 4-foot tube on the right has been browsed repeatedly. To be effective, tubes at least 5 feet tall are recommended.





the plastic, it was learned that durability could be altered readily by the quantity of ultra-violet inhibitors included in the plastic during manufacture. The yellow plastic materials used in more recent trials included these inhibitors, and they show little sign of deterioration after three growing seasons.

Problems with stakes rotting at the ground level were common to all devices in which wooden stakes were used. Without adequate support, protectors were quickly flattened by snow, usually resulting in complete loss of the seedling inside. Both ash handles and 1-inch-square pine stakes began to break off after the second year, although 65 to 70 percent were still standing after 5 years.

Another difficulty experienced with some of the plastic devices was drooping of the upper portion if the supporting stakes were not long enough. This problem was overcome by using longer stakes, but it emphasized the need for care in providing adequate support.

In some of the more recent trials with 4- and 5-foot tall plastic devices, it has become apparent that the shorter protectors are inadequate. Because these trials were not set up as an experiment, there are no data to use for comparisons, but many of the seedlings in the 4-foot tubes were browsed back repeatedly as the terminal grew out the top. Some seedlings in these short tubes may eventually escape, but this has not occurred to date. A few seedlings have also been browsed at the top of the 5-foot tubes, but most of these have grown well out of the reach of deer (fig. 3).

A supplementary benefit of the small-mesh plastic tubes is that they provide protection from girdling by mice, rabbits, and porcupines as well as protection against deer browsing. This is likely to be most important in grassy areas where small-mammal populations are high. Damage by small mammals has been observed on up to 50 percent of the seedlings on one Allegheny National Forest area.

A few seedlings have had cambium damage as a result of wind action that has caused the top of the tube to rub against the stem. This is a problem only after the seedling has grown out the top of the tube and the protector is no longer needed. The ideal situation would be to have the tube disintegrate at an appropriate time (possible with the plastic tubes); or, it may be necessary to remove the tubes after they have served their purpose. There are not enough data available yet to evaluate the extent of this damage.

Growth.—Seedling growth has not varied significantly among devices, with one exception: seedlings in the yellow plastic tubes grew slightly (and significantly) taller during the first growing season than seedlings in the other treatments. Heights were not significantly different after 5 years, although the seedlings in the yellow tubes were still slightly taller than those in the other devices (table 2).

Measurements of light quality inside the yellow tubes revealed that the proportion of far-red to red energy inside the tube was nearly three times higher than in full sunlight, as a result of filtering by the yellow plastic material. There were only minor shifts in other wavelengths.

Light that is high in far-red is known to stimulate stem elongation, and this may explain the slightly greater growth in the yellow tubes during the first year. The proportion of far-red was not significantly different from that in full sunlight in the other tubes, nor was it significantly different from full sunlight in the yellow tubes during the second growing season after the yellow color had faded from the plastic.

Air temperatures inside the plastic tubes were not significantly different from air temperatures adjacent to seedlings without tubes.

Table 2.—Height growth in the various protectors

Protective device	Total height	
	After 1 year	After 5 years [a]
	Feet	*Feet*
3-foot cattle wire	1.0	5.4
1-foot cattle wire	.8	3.7
1-foot chicken wire	.8	5.2
1-foot white plastic	1.1	—
3-inch yellow plastic	1.6 [b]	5.5
2-inch green plastic	1.1	5.1
Wooden stake	1.0	4.6
Control	.8	—

[a] Includes only seedlings on which devices were still effective.

[b] This treatment was significantly different from other treatments at 0.05 level.

Cost.—Material costs for these types of protective devices were as follows, based on 1975 prices:

- Yellow plastic tube (6-inch diameter):)$0.16 per foot.
- 2-inch mesh chicken wire (5 feet tall): $20.00 per 150-foot roll.
- Cattle wire (5 feet tall): $32.00 per 165-foot roll.
- Wooden stakes: $0.20 each.

Labor required to erect the tubes was as follows:

Fabricate & erect wire tubes: 15 per hour (2-man crew)

Erect plastic tubes: 25 per hour (2-man crew)

Cost per man: $4.00 per hour

These costs would vary depending upon sources of supply, quantities ordered, and availability of manpower. They do not include any planting costs. For the values above, the cost per protective device would be as follows:

	Tube material	*Stakes*	*Labor*	*Total*
3-foot cattle wire	$1.80	$0.40	$0.55	$2.75
6-inch plastic	.80	.20	.30	1.30
1-foot chicken wire	.40	.20	.55	1.15

Conclusions and Recommendations

These studies and trials have shown that several types of wire or plastic tubes can be erected around tree seedlings to protect them from deer browsing. In terms of cost and effectiveness, the two most promising devices are a 4- to 6-inch diameter plastic tube with small mesh and a 12-inch diameter tube constructed of chicken wire. Both types need to be at least 5 feet tall to provide adequate protection in areas of heavy browsing pressure, such as exist throughout Pennsylvania. The plastic protectors are more expensive than those made of wire, but are somewhat quicker to fabricate, and they offer the added advantage of protection against rodents.

Efforts are now under way by the U.S. Forest Service and the plastic manufacturers to develop a plastic protector that would be more easily supported and would be less expensive than present tube-stake combinations.

The minimum number of seedlings that must be grown above deer browsing height is probably somewhere between 100 and 200 per acre. If an entire regeneration area were to receive protective devices, the total cost would run between $115 and $230 per acre for chicken-wire protectors plus planting costs if natural

Figure 4.—Plastic tubes used to protect natural seedlings in those portions of a regeneration area that are being browsed severely.

seedlings were not present. This cost is high; but until some cheaper method is found, the use of protective devices seems necessary on some areas if they are to remain in forest production. The use of individual protective devices is usually cheaper than protecting the entire area with a deer-proof fence.

Use of currently available natural regeneration guidelines *(Marquis and others 1975)* could reduce the number of regeneration failures to a minimum. But even in areas classified as successfully regenerated, heavy deer browsing frequently creates pockets where stocking is inadequate. These nonstocked areas can reduce yields by important amounts, and the selective use of seedling protectors in such areas could bring the entire area to full stocking (fig. 4). Protectors also provide an opportunity to improve species composition by ensuring protection of species that are preferentially browsed (such as red maple and yellow-poplar), or —if combined with planting— of introducing genetically-improved stock or species now absent from that site.

Reference

Marquis, David A., Ted J. Grisez, John C. Bjorkbom, and Benjamin A. Roach.
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Acknowledgments

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