

A NEW LOOK AT SOIL FUMIGATION PRACTICES
FOR USE IN FOREST NURSERIES

Walter O. Miller, Dow Chemical Company

As with any industry in business today, the forest nursery industry is plagued by increasing production costs. The nurseryman is as concerned today as he was 20 years ago about weeds, soil-borne insects, diseases, and nematode problems.

There are a few new materials available for solving some of these problems; but for the most part, the chemical arsenal which can solve all of these problems is essentially the same soil fumigant arsenal available 20 years ago. The basic activity of these materials is the same as it was 20 years ago. The price of these materials has not increased appreciably during the past 20 years, or since they were introduced into the market. So what is different?

1. The cost of labor has more than tripled during the past 20 years.
2. Application methods have been refined considerably permitting more efficient use of chemicals and man power.
3. The services of highly specialized, professional applicators, using the latest equipment and procedures to accomplish optimum results are available.

Newhall in 1955 wrote, "Soil fumigation is one of the oldest and newest ways of successfully fighting soil pests." This practice reached a high state of development in Europe in the late 1800's when carbon disulphide was used on hundreds of thousands of acres in the fight against the grape phylloxera. Chloropicrin revived interest in this method after the first World War. Other fumigants began pouring from the organic chemical laboratories. Two or three hundred thousand acres of farm land devoted to tobacco, vegetables, pineapple, and ornamentals in the United States are now fumigated.

A few of the most popular soil fumigants are ethylene dibromide, the dichloropropenes, the dichloropropene-dichloropropane mixture, chloropicrin, and methyl bromide. These materials are still available as plain, hard working soil fumigants and are sold as products such as:

DOWFUME MC-2 - 98 percent methyl bromide, 2 percent
chloropicrin

PICFUME - 100 percent chloropicrin
DOWFUME W-85 - 85 percent ethylene dibromide
TELONE - 1,3-dichloropropene
VIDDEN D - 1,3-dichloropropene-propane mixture

Again to quote Newhall, "Each has a place but none is ideal."

The basic activity of these products has not changed. During the past 20 years, many workers have reported on results obtained with soil fumigants in forest nurseries. Henry (1951, 1953) reported on control of root rot in pine seedling nurseries with Dowfume MC-2 and Dowfume W-40, an early formulation of ethylene dibromide.

Kopitke (1951) reported on 3 years' observations on weed control with Dowfume MC-2. Munnecke and Ferguson (1953) obtained excellent control of soil-borne pathogens in nursery soil with methyl bromide and Foster (1956) cited the extensive use of methyl bromide in pine seedling nursery soils for black rot control.

Hansbrough and Hollis (1959) and Hansbrough, et. al. (1964) obtained excellent nematode control and increased production in loblolly pine nurseries; however, this increased growth did not carry over into the plantation. This was believed to be due to a change in nutrient compositions of the seedlings. On the other hand, Ruehle and Sasser (1962) obtained excellent growth responses in both seedbeds and out-plantings as a result of nematode control with soil fumigants.

Wright (1957, 1963, 1964) determined the importance of mycorrhizae to ponderosa pine seedlings and found excessive doses of chloropicrin adversely affected growth; however, mixtures of methyl bromide and chloropicrin stimulated seedling growth.

Many others have reported on the consistent performance of soil fumigants and have discussed modes and methods of application.

Much of the work reported in the past 10 to 15 years included various formulations of the "hard working" soil fumigants. Again, these mixtures are not particularly new to the trade, but they have proven to be effective and economical to use. Two widely used materials are Brozone and Dowfume MC-33.

The cost of chemicals for nematode control alone range from approximately \$35 per acre for a broadcast treatment of Dowfume W-85 (at 6 gallons per acre) to \$42 for Telone (at 20 gallons per acre). The latter is recommended for use from 20 to 72 gallons per acre on a broadcast basis.

The broad spectrum fumigants, such as Dowfume MC-2, Dowfume MC-33, and Brozone, will cost from 5200 to 5650 per acre, depending upon the rates used.

Most of the economic studies done with soil fumigants in forest nurseries have been concerned with weed control. Kopitke (1951) used Dowfume MC-2 in black locust, cottonwood, and multiflora rose seedbeds and concluded that fumigation costs of \$335 per acre (including labor, etc.) produced a net savings of 5550 per acre. Wycoff (1955) tabulated costs of 8619.22 per acre in the Mason State Tree Nursery in Illinois over the 1951-1954 period (using Dowfume MC-2). Labor averaged \$154.72 per acre per year during that period. The fumigation reduced the total annual nursery operation expense per thousand plants by one-third, a savings of \$38,000 per year. Seedling density was increased by as much as 168 percent.

Mony (1959, 1961) cited costs of \$234 per acre to fumigate with methyl bromide. Terrell (1962) reported costs of \$492 per acre using a methyl bromide-chloropicrin mixture. Not all of the fumigant trials have been highly successful as Anderson (1964), using similar mixtures as well as Telone, concluded the high cost of fumigant materials was prohibitive in certain nurseries in the Northwest. Although weeding costs were reduced, the net production costs per thousand seedlings were two to three times as great as that of non-fumigated production.

Shoulders, et. al. (1965) reported on costs of up to \$800 per acre for fumigation with methyl bromide; however, weeding costs were reduced for 2 successive years following the fumigation.

Other investigators have reported on tests with various soil fumigant formulations. Morris (1960) evaluated Brozone, Dowfume MC-2, a methyl bromide-chloropicrin mixture, and Vapam. He concluded that methyl bromide and its formulations produced the greatest number of surviving seedlings. Similarly, Clifford and Massello (1966) found methyl bromide formulations superior to other soil fumigants in seedling production. White and Potter (1963) evaluated several fumigant materials in the greenhouse and nursery. Dowfume MC-2 and Brozone gave excellent weed control and seedling survival. Howe and Clifford (1962), using various rates of Dowfume MC-2, Brozone, and a methyl bromide-chloropicrin mixture, concluded from tests that all treatments: (a) increased seed germination, (b) increased seedling stand and vigor, and (c) reduced chemical weed control and all but eliminated expensive hand-weeding.

Schreiber, et. al. reported that Dowfume MC-22 and Brozone were highly effective against pigweed, lambsquarter, velvetleaf, prickly sida, venise mallow, giant foxtail, and yellow nutsedge. Crabgrass was also controlled; however, ivyleaf morning glory was not controlled. Generally, the families of hard-coated seeds, Convolvulaceae and Leguminosae (Fabaceae) are not controlled by soil

fumigation unless the seeds have germinated at time of application.

There are several factors involved in using soil fumigation. First, consider the four groups of pests (soil-borne insects, nematodes, weeds, and soil-borne diseases) that justify soil fumigation in nursery beds.

Certainly, one could not afford to use a broadcast fumigation for soil insect control alone; on the other hand, a broadcast application of an excellent nematicide, such as Telone or Dowfume W-85, may well be justified where insects and nematodes are both a problem. Many situations require complete control of soil pests. For instance, weeds may be the major problem, yet cannot be handled economically with hand-weeding or the standard herbicides. On the other hand, the problem may be soil-borne diseases, such as the root rotting fungi, various wilt, or damping-off diseases.

The problems, then, dictate to some extent what type of fumigant should be used; however, the use of broad spectrum fumigants, such as Brozone or Dowfume **MC-33**, can usually be justified in most nursery situations.

Application methods have been refined, mainly in the area of handling and applying the broad spectrum fumigants. We have gone from the hand application of Dowfume MC-2 under treated kraft paper to the refinements of continuous tarp laying. This is usually a custom turn-key service which can very likely be justified in most forest nursery situations. In summary, what are the advantages of soil fumigation in forest nurseries?

1. A broad spectrum fumigant, such as Brozone or Dowfume **MC-33**, reduces damage and costs caused by the soil pest problems, weeds, disease, insects, and nematodes.
2. The treatment results in reduced seeding rates, more rapid seedling growth, and more uniform stock.
3. Seedlings have greater vigor; they ship better.
4. The nursery capacity is increased through increased production.
5. A custom application with continuous tarp layer is thorough, giving more uniform pest control throughout the seedbed.

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