REFINEMENT OF DAZOMET APPLICATION FOR SOIL FUMIGATION. J. Juzwik, USDA Forest Service, North Central Forest Experiment Station, St. Paul, MN; R. R. Allmaras, USDA Agricultural Research Service, St. Paul, MN; D. L. Stenlund, Department of Biological Sciences, University of Minnesota, St. Paul, MN; and S.M. Copeland, USDA Agricultural Research Service, St. Paul, MN

Dazomet (a.i. = tetrahydro-3,5,-dimethyl-2H-1,3,5, thiadiazine-2 thione) is an alternative chemical to methyl bromide for soil fumigation to control soil-borne pests in agriculture, horticulture, and forestry. The commercial product available is a fine, white granular formulation that is normally applied through drop-type spreaders, immediately incorporated into the soil, and physically sealed by rolling and applying a water seal or polyethylene tarp. The fumigant volatilizes upon contact with soil water.

Dazomet efficacy depends on the uniformity and depth of incorporation among other factors. The manufacturer of dazomet has recommended using rotary hoes and disks for the most uniform incorporation of the product. Depth of incorporation needed depends upon the pathogen or pest to be controlled; the most difficult ones (Verticillium and Fusarium) require treatment to a depth of 30 cm and an application rate of 425 kg/ha (380 lbs/ac). We field evaluated selected tillage equipment currently available to forest nurseries for incorporation of granular pesticides. Uniformity or degree of mixing and depth of incorporation were measured using ceramic spheres as tracers. Fungicidal effectiveness of dazomet to 30 cm depth is being determined in operational trials following chemical incorporation with the most promising implements. All studies have been conducted in bareroot forest nurseries with either loamy sand or sandy loam soils.

Fluorescent green or red ceramic spheres (1-3 mm dia) were evenly applied to the soil surface of two randomly determined areas (approx. 2 x 3 m) in designated lanes of selected fields for evaluating each implement. Three rotary tillers (different manufacturers) and a digging machine were used at recommended operational tractor ground speeds and PTO rpm to incorporate the spheres. Sampling transects utilizing a wooden template with evenly spaced sampling holes were used to measure mixing/ incorporation across the width of the implement lane (transverse transect at 37°) or dragging of surface material (longitudinal transect parallel with direction of travel) within the soil profile. Soil cores (1.8 cm dia x 30 cm long) were taken through the holes with a tube sampler. Single soil cores ($\geq$ 39 per transect line) were cut into 2- cm depth increments and placed in separate envelopes; 4- cm depth increments of three single soil cores per sampling location were composited for each longitudinal transect ($\geq$ 29 per line). Number of spheres in each depth increment were then determined for both sample types. Patterns of sphere distribution (horizontally and vertically) were identified for each implement. Longitudinal dragging of spheres in direction of implement travel was also found to different degrees. Spatial analysis is being used to describe uniformity of sphere incorporation. Ceramic spheres and the evaluation protocols are field worthy for evaluating equipment and associated incorporation of small, granular surface material. Functional correlation between incorporated spheres and dazomet granules will be further investigated.

The ceramic spheres also allowed for comparison of equipment performance. All three rotary tillers in this study gave a similar clustering of spheres at depths characteristic of each implement. Maximum incorporation depth ranged from 12 to 20 cm for the tillers. Extensive longitudinal drag of spheres in the top 8 cm was found for one tiller. Of the four implements tested, the digging machine produced the most consistent and deepest incorporation and the most uniform distribution of spheres throughout the depths examined. These preliminary results suggest that rotary tillers with bent tines are not the best implement type for uniformly incorporating granular surface material.

One of two planned dazomet evaluation trials was conducted in early August 1994. Pre-fumigation soil samples were taken to assay Fusarium spp. and Cylindrocladium spp. at different depths. Dazomet was then applied to the field with a drop-type spreader; half the field received 285 kg/ha (255 lbs/ac) and the other half received 570 kg/ha (510 lbs/ac) of product. Four contiguous traffic lanes were established across each half for the entire length of the field 15.5 x 155.4 m (51 x 510 ft). Each implement was then used to incorporate the dazomet in the implement's designated lanes. Two of the four implements were equipped with a roller that immediately compacted the soil surface. After all incorporation was complete, a separate roller was used to compact the surface soil across all treatments before irrigating. Soil cores were taken after rolling but before watering to determine chemical activity by depth in each treatment. A lettuce seedling bioassay was used to indirectly assess this activity. Measurements of soil resistance to penetration were taken with a cone penetrometer before and after tillage to accurately determine tillage depth. Chemical bioassay correlated well with distributional patterns determined for each implement in the screening trials with spheres. Fungal populations determined for post-fumigation soil samples (4 wk after treatment) will be compared with the chemical assay. We anticipate that direct readings of methylisothiocyanate levels (primary breakdown product of dazomet) in the soil at different depths will be made in the 1995 field trial.

In summary, ceramic spheres are useful as tracers for evaluating tillage equipment and associated incorporation of surface-applied, granular material. Due to non-uniform and shallow mixing, rotary type tillers may not be the best implement type for incorporating granular fumigants. Chemical field trials are currently underway to test this observation.