Incorporation of Surface-Applied Materials by Tillage Implements[1]

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Maximum depth and uniformity of incorporation of surface-applied materials by rotary tillers, a spading machine, and a disc cultivator were compared in Wisconsin nursery (loamy sand soil) and Michigan nursery (sandy loam soil) trials using ceramic sphere tracers (1 - 3 mm dia). The tracers or beads were spread uniformly over the soil surface and different tillage implements were then operated through these areas as they traveled the length of each study field. Results of these trials are applicable to situations involving incorporation of such materials as granular fumigants or herbicides, granular fertilizers, peat, and cover crop residues.

Results:

The maximum depth of consistent bead incorporation for each implement in the Hayward Nursery (WI), trial as measured across the working width of each was:

Gramegna spading machine	10 inches
Fobro Kultipak 1700 rotary tiller	5 inches
Kuhn rotary tiller	5 inches
Northwest rotary tiller	8 inches

The "peaks and valleys" observed in tracer recovery in the vertical soil profile across the width of the implement path of travel mirrored the number of tools (i.e. flanges or spades) per implement. Based on amount of beads spread on the surface, one bead should have been recovered per 1/4-inch depth increment to a 12-inch depth if a completely uniform distribution were achieved. In comparison to this standard, the Gramegna gave a distribution closest to the ideal with one to seven beads recovered per depth increment down to 10 inches compared to that found for the other equipment. The second best implement for uniformly incorporating beads was the Northwest tiller. Incorporation by all three rotary tillers led to concentrated clusters of beads, but the longer length of the Northwest tiller tines resulted in deeper occurrence of those clusters.

In the Toumey nursery trial (Watersmeet, MI), the maximum depths (inches) of consistent tracer incorporation across the sampled width for the implements (full width for the Gramegna and Fobro; half width for the disc) were:

Gramegna Spading Machine	7.0 inches

Fobro 1250	3.5 inches
John Deere disc cultivator	5.0 inches

The most consistent distribution down to 5 inches across the sampled increment width was found for the disc which had been run twice through the trial plots in opposite directions. The Gramegna also gave fairly uniform distribution to 7 inches but with an unexplained gap in the center of the working width that was consistent in each of the six replicate plots.

Discussion:
The maximum depth of incorporation and soil disturbance in these and related dazomet trials (not discussed here) was greatest for the spading machine in trials at the two nurseries. Differences in penetration depths were observed between the nurseries for the Fobro and the Gramegna, and these were attributed to pre-incorporation soil conditions, i.e. no tillage just prior to incorporation in the Wisconsin nursery versus tillage with a disc just prior to the Michigan incorporation trial. The more shallow maximum depth of consistent bead incorporation in the Michigan nursery may also be due to the increased ground speed of implement operation (2 mph for all three implements) compared to the Wisconsin trial in which ground speed varied according to implement based on equipment distributors' recommendations. The most uniform distribution of surface applied materials was obtained using the spading machine when comparing the two trials.

Application:
Selection of tillage implement to use for incorporating surface applied material should be based on the result desired. For instance, vertical distribution of target pests should be considered when incorporating the granular fumigant dazomet. Nursery operations staff should also remember that soil compaction may also result from tillage implement use in moderate to high soil moisture conditions, particularly with rotary tillers with sharper tine angles.

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[1]*Stenlund, D.L.;Juzwik, J.;Allmaras, R.R.; and Copeland, S.M. 1997. Incorporation of Surface-Applied Materials by Tillage Implements. In: Landis, T.D.; Thomspon, J.R., tech. coords. National Proceedings, Forest and Conservation Nursery Associations. Gen. Tech. Rep. PNW-GTR-419. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 29-30.*

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