Potted chrysanthemum plants grown to maturity by incorporating ion exchange resins into soil prior to planting cuttings, January 20, 1961. Pot on the left (C) received 0.4 g of nitrogen from urea-formaldehyde plus single superphosphate and potassium glass frit incorporated into the soil before planting. Thereafter the plant was maintained on a liquid fertilizer program until flowering—a program considered to be essentially perfect. Plant 2 received 10%, plant 3 received 5%, plant 4 received 3.3%, and plant 5 received 2% of exchange resins by volume of the total soil. Treatments 2 through 5 were maintained only with tap water after planting. The control treatment (C), and treatment 3 produced plants of excellent commercial quality, but treatment 2 was somewhat better and matured earlier. When 3.3% or less exchange resins were used, the plants were nitrogen deficient and of inferior quality.

volume, of the resin was included in the soil mix. Six per cent by volume was also very effective except for aphelandra, where it was apparently too low. A volume percentage of 12—of the ion exchange resin fertilizer—proved to be too high for aphelandra, philodendron and sheffelera. Optimum application rates will depend on the plant species, irrigation practices and water quality.

Single applications of ion exchange fertilizers are capable of supplying nutrients at an adequate rate over periods of up to three months, under typical nursery conditions, with a relatively good margin of safety against injury from excessive application. This is adequate for the production of many of the potted plant crops.

Ammoniated sawdust

The ammoniation of sawdust or other types of cellulose-containing materials provides a means of producing organic nitrogen and improving the utility of organic wastes. The reactivity of ammonia with organic matter has been known for some time and the commercial utilization of the process has been investigated by several groups. In one process being developed commercially, sawdust is acidulated, heated to an elevated temperature and neutralized with anhydrous ammonia. The product has a charred appearance but otherwise has the shape and size of the original sawdust. Phosphoric acid may be used for acidulation, making the resultant product also a carrier of phosphorus. Of particular interest is the fact that about one half of the nitrogen has been converted into insoluble forms and the remainder is apparently intimately distributed through the particles, presumably combined with the acid negative ion. The following properties were found for a sample supplied by the producer.

Percentage of Nitrogen soluble in water	47
Percentage of Nitrogen soluble in normal sodium chloride	53
Percentage of Nitrogen distillable with magnesium oxide	58
Percentage of Nitrogen in exchangeable form	9
Positive ion exchange capacity per 100 g.	43
Increase in soluble salts in soil mix solution per lb Nitrogen per cubic yard of soil	3200 ppm

The moderate increase in soluble salts shows that substantial amounts of nitrogen can be applied at a single application. Using material containing 4 per cent total nitrogen, as much as 1.5 lb of nitrogen has been incorporated into soil per 100 square feet without injury to typical ornamental plantings. About one half this quantity can be incorporated per cubic yard of soil mix. These rates are about three or four times as high as are safe with inorganic nitrogen sources. Plant response has been rapid since about one half of the nitrogen is water soluble. The water soluble fraction diffuses out of the particles slowly when the soil is not saturated with water. The organic fraction of the nitrogen is mineralized in about four to six weeks under favorable conditions.

Ammoniated sawdust is also of interest because of its contribution to physical properties of soils. Having a low bulk density of about 16 pounds per cubic foot, it is an effective diluent in fine textured soils and improves soil tilth. The chemical and physical properties of ammoniated sawdust adapt it well for use in landscaping operations—particularly new installations in subsoils or other poor soil situations. Observations extending over a five year period indicate the "charred" sawdust is decomposed very slowly. As a soil amendment the ammoniated sawdust has a long life.

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HYDROGEOLOGICAL STUDIES

A PILOT INJECTION of tritiated water has been made into the groundwater in a study of the groundwater and surface hydrology of foothill areas in the Sierra Nevada in Placer County. Results from the initial trials confirm the movement of groundwater in the jointed rock formations as predicted from groundwater contour maps. The movement and subsequent detection of the tritiated water over distances of hundreds of feet indicates that the joint system is well connected.

Tritiated water injected into wells at depths of 40 feet below the surface has been detected in the leaves of native oak trees downslope from the well, showing that these trees are obtaining part of their water supply from the groundwater system. These results will lead to more refined studies of the depth of rooting of trees and brush species and of their dependence on and the magnitude of water use from groundwater.—*Robert H. Burgy and David C. Lewis, Jr., Department of Irrigation, University of California, Davis.*