is \$2.00 per acre. At a rate of \$22.82 for one combine and operator plus a bankout wagon, tractor and man, the benefit for reduced harvest time is \$4.79 per acre. A benefit-less-cost figure is given below for the two comparisons:

1. Plastic Levees vs. Three-year-old Soil Levees

Total cost of plastic levees	\$11.11 per acre
Total annual cost of 3-year-old soil levees	1.88
Added increment of cost due to plastic levees	\$9.23 per acre
Benefits resulting from use of plastic levees:	
.28 hr. per acre saving in tillage operations	\$2.00
.21 hr. per acre saving in harvest operations	4.79
2.20 sack per acre increase in rice yield	9.90
Total savings per acre	\$16.69
Net additional earnings per acre = \$16.69 – 9.23 = \$7.46	

2. Plastic Levees vs. New Soil Levees

Total cost of plastic levees	\$11.11 per acre
Total cost of new soil levees	3.80
Added increment of cost due to plastic levees	\$7.31 per acre
Benefits resulting from use of plastic levees:	
.21 hr. per acre saving in harvest operations	\$4.79
1.30 sack per acre increase in rice yield	5.85
Total savings per acre	\$10.64
Net additional earnings per acre = \$10.64 – 7.31 = \$3.33	

If growers receive extra income from rice lands used for game hunting, the weed growth is a benefit in favor of old soil levees and should be deducted from the benefits of plastic levees in figuring additional earnings.

Since there are substantial net additional earnings per acre for the example given, it is economically feasible to replace soil levees with plastic levees. It must be kept in mind that the costs compared depend on the length of levee per acre, and the benefits of increased yield are dependent on both length of levee per acre and the average yield. A new calculation of costs and benefits must be made from the tables and graphs for every field where a change in levee construction practice is being considered. The only foreseeable change in plastic levee economics is that the costs may decrease as further mechanization is accomplished—improving the economic feasibility of plastic levees.

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IMPROVING YIELDS IN SELF-POLLINATED CROPS

Some mixtures of pure-line varieties of self-pollinated crops show promise of improving yields and stabilizing productivity, as compared to the pure lines.

In the past half-century much of the improvement in yielding ability of crops such as barley, wheat and beans has resulted from selecting pure-line varieties—consisting of a single genetic type.

These pure-line varieties are highly uniform for such features as size, maturity, disease resistance, and quality factors that improve their marketability. Valuable as these pure-line varieties have been, there are theoretical reasons for believing that certain types of mixed populations may be still more useful in agriculture.

Investigations have been conducted to test the theory that mixtures which provide a controlled measure of genetic diversity may not only yield more than a single pure line but also perform more steadily year after year. Under test is the idea that individual plants may encounter different environments not only within fields but also in different locations and years, and that different plant types may be able to exploit particular sites to their own particular advantage and to the advantage of the entire population.

One experiment with lima beans conducted at four locations over four years indicated that mixtures of pure lines were less likely to produce as high yields—or as low yields—in any one year as the best pure line included in the mixtures. The important point is that certain of the mixtures yielded more, when averaged over several years, than the best constituent pure line included in the mixture.—*R. W. Allard, Professor of Agronomy and Agronomist, Department of Agronomy, University of California, Davis.*

UREA FORM

T. G. BYRNE · O. R. LUNT

Urea formaldehyde was the first major synthetic nitrogen source developed for controlled availability. It has been commercially available for about a decade and primary uses have been with turfgrass and ornamentals. To obtain satisfactory responses, several aspects of its properties must be understood.

In the manufacture of urea formaldehyde these two components react to form polymers of various complexity. The ratio of urea to formaldehyde, and other factors affecting the reactions, influence the susceptibility of the product to mineralization—namely, conversion of the nitrogen to ammonium or nitrate forms. Commercial materials vary, particularly in the fraction of the total material that is readily available.

In commercial materials a substantial portion of the total nitrogen (25 per cent or more) is cold-water soluble. This fraction is of low molecular weight and is nitrified readily. The bulk of this fraction nitrifies, when conditions are favorable, within a four-week period. The remaining fraction which is relatively resistant to nitrification is mineralized at a much slower rate.

Under typical greenhouse soil conditions, about 6 to 7 per cent of the fraction relatively resistant to mineralization is converted to nitrate or ammonium each month. There is also some evidence that this rate tends to increase as the resistant fraction ages. From a given initial supply of this type of nitrogen the yield of mineral nitrogen tends to remain more nearly uniform than would be expected.

The 6 to 7 per cent rate of mineralization per month is some 50 times as fast as natural soil humus is mineralized. Thus, nitrogen from "residual" urea-formaldehyde is much more available than nitrogen from soil humus.

ALDEHYDE

CONTROLLED AVAILABILITY FERTILIZERS

PART IV OF A FIVE PART SERIES

Urea formaldehyde has been promoted on its ability to supply nitrogen at a slow, steady rate for prolonged periods. Its successful use in this role is dependent on the development of an adequate level of "residual" nitrogen in the soil.

A common cause of disappointment from the use of urea formaldehyde is the failure to develop this adequate reserve.

The level of "residual" nitrogen is influenced by management practices including soil texture and the amount of deep percolation occurring. Local management conditions will affect details regarding the successful development of such nitrogen-fertilization programs based on infrequent applications of U-F. As a point of reference, however, the establishment of about 2½ pounds of nitrogen in "residual" urea formaldehyde per 100 square feet of soil area (or 0.05 per cent nitrogen in the soil from the "residual" fraction) has been shown to adequately supply nitrogen for prolonged periods for such crops as turfgrass or commercial carnations. The soil level can be maintained by making applications as infrequently as once every five months. However, many management programs would not require this large residual amount to maintain a good nitrogen supply.

Application rates

Greenhouse production data on carnations indicates that once the proper level of urea formaldehyde has been established in the soil, annual application rates are no larger than those required when frequent applications of soluble materials are made. Three pounds of nitrogen per 100 square feet per year is an ample rate. In other words, the efficiency of recovery of nitrogen from urea formaldehyde is as good and probably better (as a rule) than that from similar annual amounts of soluble materials—under otherwise similar management programs.

Since the mineralization of urea formaldehyde is dependent on microbiological attack, soil conditions which influence the activity of micro-organisms directly influence the rate of supply of nitrogen from urea formaldehyde. The availability of nitrogen from U-F declines with cooler soil conditions.

Large applications of U-F can be safely made in a single application. Since it is dependent on microbiological attack to yield its nitrogen, it is most effective when incorporated in the soil. Applications as large as six pounds of material (2.3 lbs of nitrogen) per 100 square feet—or half this amount per cubic yard—of soil mix may be incorporated safely without injury to most seedlings, if the soluble salt level of the soil is low.

Biuret impurities

Since large amounts of this fertilizer can be applied in a single application there has been some apprehension about possible injury from biuret impurities in the urea from which the U-F was made. Tests using U-F which had been synthesized with 5 per cent mole substitution of biuret for urea showed injury on radishes when used at maximum application rates if the synthesis was conducted at 90° C. When synthesis was performed at room temperature twice this level of biuret was required to produce injury, whereas mechanical mixing of biuret into U-F at the rate of 2.5 mole per cent of the urea resulted in injury. These tests indicate that if biuret is present in urea used for synthesis, a portion of it would either be condensed or occluded in the U-F reaction.

A 5 per cent mole substitution of biuret for urea corresponds to a biuret concentration of about 8.6 per cent in the urea. This degree of biuret contamination is relatively high. Since biuret is also subject to microbiological decomposition, it appears very remote that injury would develop from this source from the use of U-F materials. Manufacturers should, of course, use urea of low biuret content in the manufacture of urea formaldehyde.

We have not been consistently successful in producing short term ornamental crops such as potted chrysanthemums (about 10 to 12 weeks) from a single application of urea formaldehyde, although two applications carry the plant very well. A very desirable use for U-F materials is as a supplemental dry fertilizer in a soil mix where liquid fertilization is used. Many liquid fertilizer programs are not adequate on new plantings.

Urea formaldehyde seems best adapted to the long term maintenance programs such as for turfgrass. For satisfactory performance, the normal nitrogen requirements for a period of about a year must first be developed in a soil over a period of several months before an adequate rate of supply of mineral nitrogen will be available. Subsequently, rates must be adjusted to the normal, desired annual rate of nitrogen application. Experience has shown that the interval between applications when these conditions are reached may be as long as five months without significantly affecting the performance of the crop.

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Data reported here were obtained principally from urea formaldehyde supplied by the Du Pont Co.