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Foliar Sprays for Supplying Major Nutrient Elements

Purdue University Cooperative Extension Service
FOLIAR SPRAYS FOR SUPPLYING MAJOR NUTRIENT ELEMENTS

SUMMARY

Foliar sprays have been used successfully to correct minor element deficiencies in fruit trees and certain field crops. The greatest difficulty in applying nitrogen, phosphate and potash in foliar sprays is the problem of spraying adequate amounts of these major elements without (1) causing severe burning of the leaves, and (2) without using an unduly large volume of solution or large number of spraying operations.

Foliar applications of nitrogen in the form of urea solutions have been successful in some areas. Nitrogen applied as urea in a foliar spray at rates of from 10 to 50 lbs. of nitrogen per acre produced increases in wheat yields from 6 to 14 bushels per acre in Kansas and Indiana. The experiments in Indiana showed that soil applications of nitrogen were just as effective in increasing wheat yield as equal amounts of nitrogen applied as foliar sprays. Indiana workers also found that urea sprays increased corn yields, however, soil applications of ammonium nitrate produced equal increases in yields.

Little information on the use of foliar sprays for application of phosphate and potash on field crops is available. The low concentrations of phosphate and potash that must be used to prevent severe damage to leaf surfaces together with the relatively large phosphate and potash requirements for high yields of field crops such as alfalfa, corn and wheat make foliar application of the major portion of the plant requirements of these two elements impractical with present techniques.
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A Review

The idea of feeding plants through the leaves is not new. Solutions containing minor elements have been sprayed on the leaves of fruit trees to successfully correct deficiencies (7) since about 1933. Recent studies (1,2,5,6) indicate that a satisfactory level of nitrogen and magnesium nutrition can be maintained in apple trees by sprays of urea and epsom salts, respectively. Recent developments such as the increased availability of all-soluble, complete fertilizers have caused considerable interest in the possibilities of applying major nutrient elements to field crops through foliar sprays.

ADVANTAGES AND DISADVANTAGES OF APPLYING MAJOR NUTRIENT ELEMENTS AS FOLIAR SPRAYS

In certain cases the use of foliar sprays is the most convenient and feasible method of preventing deficiency symptoms. It may be possible to increase efficiency of utilization of fertilizer material somewhat by spraying (10, 12), but the amounts of the major nutrients necessary to produce appreciable yield increases are relatively large and would necessitate the use of inconveniently large volumes of spray solutions at the dilution needed to avoid burning (8). Plant response is sometimes more rapid to sprays (12) than when nutrients are added to the soil.

Not all plants respond to nutritional sprays in the same manner. A spray that is effective in supplying nitrogen for apples may have no effect on tomatoes. Also, the compound that works best for a given foliar spray may not be easily obtained or comparable in price to other compounds that are effective when added to the soil. The greatest obstacle yet to be overcome is the problem of spraying adequate amounts of the major elements without causing severe burning of the leaves and without using an unduly large volume of solution or large number of spraying operations.

The following brief review of current research reports on foliar sprays for field and vegetable crops gives the present status of research for the three major nutrients.

Nitrogen: Of a number of nitrogen compounds tested, urea has been used most successfully in foliar sprays.

Wheat - Finney, (Kansas) (4), reported significant increases in yield and protein content from application of foliar sprays of urea (Nugreen) on Pawnee wheat. Application rates were 10, 30 and 50 pounds of nitrogen per acre using spray concentrations of 25, 75 and 125 pounds of urea per 100 gallons respectively. One single spraying seven weeks before flowering gave a yield increase of 6 to 12 bushels per acre depending on the application rate.

Montenegro (Indiana) (8), found that foliar application of nitrogen in the form of urea was as effective a method of supplying nitrogen to wheat as surface broadcast applications. The urea was applied at rates of 6, 12, 24, and 48 pounds of nitrogen per acre in the form of a spray solution containing 50 pounds of urea per 100
gallons of water. Care was taken to apply all of the solution to the foliage. At the heavier rates of 24 and 48 pounds nitrogen per acre, a strong marinal and tip burning in the wheat leaves was produced; this effect disappeared ten days later. The 6-pound rate produced no significant increase in yield regardless of whether applied as a spray or added to the soil. Application of 48 pounds of nitrogen per acre when the wheat was 6 inches tall produced the highest yield obtained from foliar sprays, 40.5 bushels per acre—an increase of 14 bushels over the check plot. There was no significant difference in recovery of the nitrogen applied as a foliar spray compared to soil application.

Corn—Shubeck and Caldwell (Minnesota) (11), conducted experiments on the use of urea as a foliar spray for addition of supplemental nitrogen to corn. They report that foliar applications of 7.5, 15, and 30 pounds of nitrogen per acre in the form of urea solution (Nugreen) produced no significant differences in yields. Severe marginal burning of leaves was observed. Montenegro, Foy, and Barber (Indiana) (9), found that applications of 20 pounds of nitrogen as a urea spray or as side dressing of ammonium nitrate were equally effective in increasing yields of corn. At the 40-pound rate, soil applications gave greater in increases in yields.

These results are shown in Table 1.

Table 1. Comparison of Foliar Spray and Soil Applications of Nitrogen for Corn.

<table>
<thead>
<tr>
<th>Rate, N/Acre</th>
<th>Material and Method of Application</th>
<th>Yield increase, bushels/acre</th>
<th>Field A</th>
<th>Field B</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Urea as foliar spray</td>
<td>6.6</td>
<td>13.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ammonium nitrate-side dressed</td>
<td>7.0</td>
<td>13.4</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Urea as foliar spray</td>
<td>7.5</td>
<td>14.8</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Ammonium nitrate-side dressed</td>
<td>9.3</td>
<td>20.6</td>
<td></td>
</tr>
</tbody>
</table>

One of the foliar sprays contained 50 pounds of urea per gallon of water. To apply nitrogen at the rates of 20 and 40 pounds per acre this foliar spray required spray volumes of 104 and 208 gallons respectively. A more concentrated solution of urea (200 pounds per 100 gallons of water) produced severe burning and actually depressed the yield to the level of the check plot on Field A. There is a definite inconvenience in handling large volumes and weights of solution needed to add adequate amounts of nitrogen. Some idea of the amount of a particular nutrient element that must be added to increase crop yields can be obtained by determining how much more of the element is present in a high yield of a given crop as compared to a lower yield. Take, for example, nitrogen in corn. There are approximately 93 pounds of nitrogen in 60 bushels of corn (grain and stover). A 100 bushel corn crop contains about 160 pounds of nitrogen. Thus to increase the corn yield from 60 to 100 bushels, at least 67 pounds of nitrogen must be added. This assumes the added nitrogen to be 100% efficient, which it is not. In practice
larger amounts must be added. Thus it is not possible to spray corn
with 3 gallons of a liquid fertilizer containing 2 or 3 pounds of
nitrogen and obtain a really significant yield increase from the added
nitrogen. Similar calculations could be made for other crops and nu-
trient elements.

Tomatoes - Patterson (New York) (10), in studying the application of
urea as a foliar spray for tomatoes found that the plants receiving ad-
ditional nitrogen through the roots were far superior in size, color,
and set of fruit to any receiving it through the leaves regardless of
when the supplementary nitrogen was added.

Phosphorus: Silberstein and Wittwer (Michigan) (12), found that tomato,
bean, and corn plants grown at low phosphorus levels gave definite early
growth responses to foliar applied phosphorus as indicated by height and
plant weight measurements. However, the difficulty of supplying amounts
of phosphorus sufficient to produce significant yield increases is very
strikingly shown in this study. To apply 2.73 pounds of P2O5 per acre
as a foliar spray without damaging the foliage required 4 spray appli-
cations of 40 gallons each. This foliar application of 2.73 pounds of
phosphorus resulted in more early fruit than did 135 pounds applied
broadcast to the soil as treble superphosphate. There was no signifi-
cant increase in total yield from foliar applied phosphorus. The phos-
phorus applied to the soil did produce significant increases in total
yield over the check plots.

Potassium: Only meager data are presently available on the use of foliar
sprays containing potassium. Hamilton, et al (New York) (6), used
potassium nitrate as one of several possible sources of nitrogen in
foliar sprays for apple trees. The sprays containing nitrate materials
(potassium and sodium nitrate) at concentration of 5 pounds of potassium
nitrate to 100 gallons of water, caused considerable foliage injury,
possibly due to the reaction with the arsenate of lead even though lime
was used at 3 pounds to 100 gallons of water. Potassium nitrate was the
least injurious of the nitrates used.

Burrell and Bounton (New York) (3), report the use of a 1% solu-
tion of potassium sulfate as a foliar spray for reducing leaf spr.
ch of scorch in McIntosh apples. Five sprays at the rate
of 2 gallons per tree added approximately .04 pounds of potassium per
tree.

Patterson (New York) (10), states that potassium chloride has been
used in some areas in the regular spray schedule on celery.

Considering the potassium requirements of a 4-ton alfalfa hay
crop (178 pounds potassium), a 100 bushel corn crop (125 pounds
potassium), or a 30 bushel wheat crop (30 pounds potassium) the
problem of adding adequate amounts of potassium in a foliar spray
without serious injury to leaf surfaces and without using inconveniently
large volumes of solution becomes an extremely difficult one.


8. Montenegro, G. Urea foliar sprays for the application of supplemental nitrogen to wheat and corn. M. S. Thesis, Purdue University, 1951 (Dr. S. A. Barber, Advisor)


