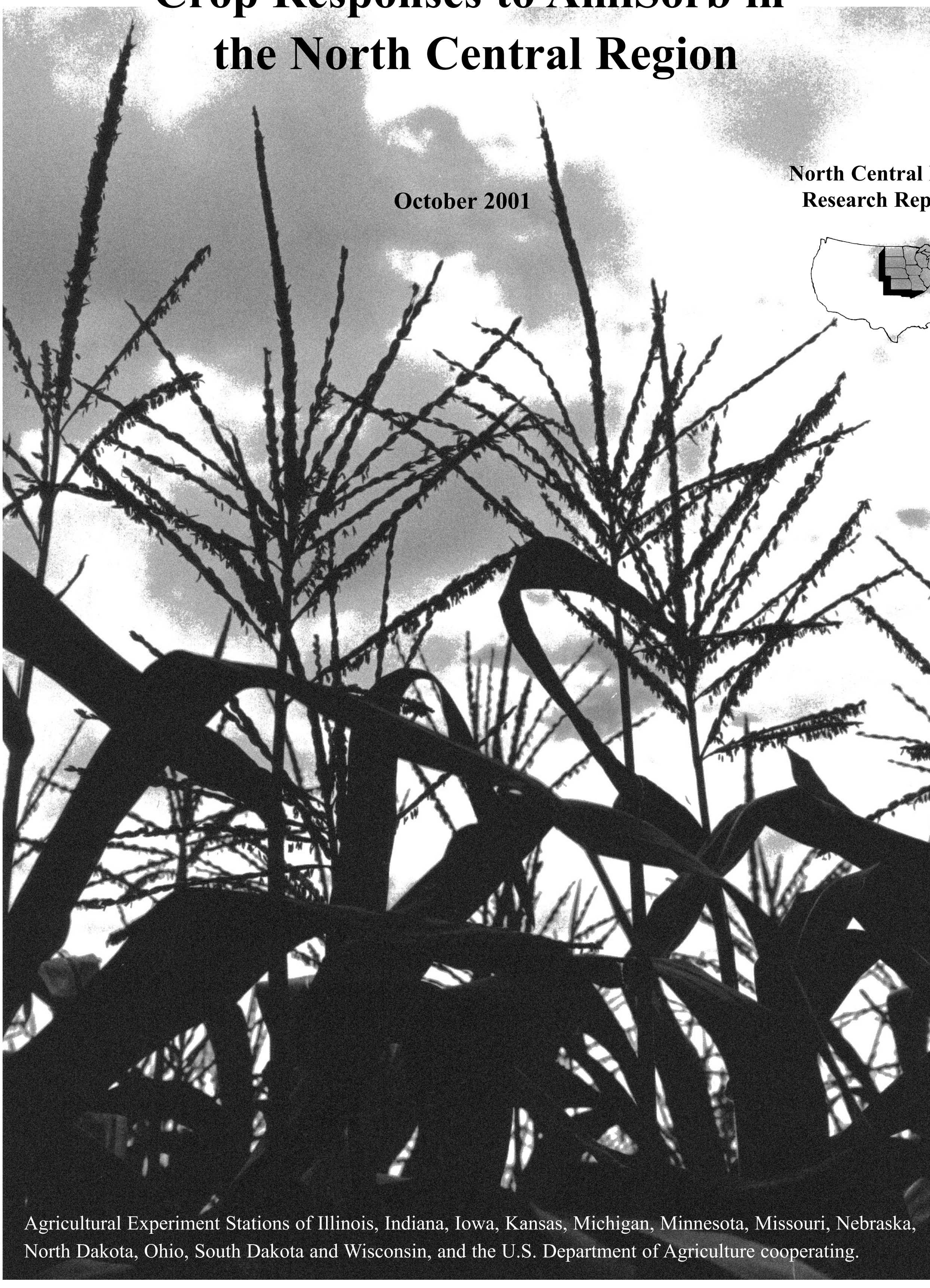
Crop Responses to AmiSorb in the North Central Region



October 2001

North Central Regional
Research Report 347

Agricultural Experiment Stations of Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota and Wisconsin, and the U.S. Department of Agriculture cooperating.

PUBLISHED BY THE COLLEGE OF AGRICULTURAL AND LIFE SCIENCES ■ UNIVERSITY OF WISCONSIN-MADISON

For information on the availability of copies of this publication, contact:
Keith Kelling
Dept. of Soil Science
University of Wisconsin-Madison
1525 Observatory Dr.
Madison, WI 53706-1299
Email: kkelling@facstaff.wisc.edu
Phone: (608) 263-2795
Fax: (608) 265-2595

Also available at: www.soils.wisc.edu/extension

[1/] This bulletin was produced by the North Central Region's NCR-103 Committee. Supporting institutions and their NCR-103 Committee members are: Sylvie Brouder (Purdue Univ.), Robert Dowdy (USDA-ARS, St. Paul, MN), Dave Franzen (North Dakota State Univ.), Gary Hergert (Univ. of Nebraska), Robert Hoeft (Univ. of Illinois), Maurice Horton (Cooperative State Research, Education, and Extension Service, Washington, DC), Keith Kelling (Univ. of Wisconsin-Madison), David Mengel (Kansas State Univ.), George Rehm (Univ. of Minnesota), John Sawyer (Iowa State Univ.), Peter Scharf (Univ. of Missouri), Darryl Warncke (Michigan State Univ.), and David Whitney (Kansas State Univ.).

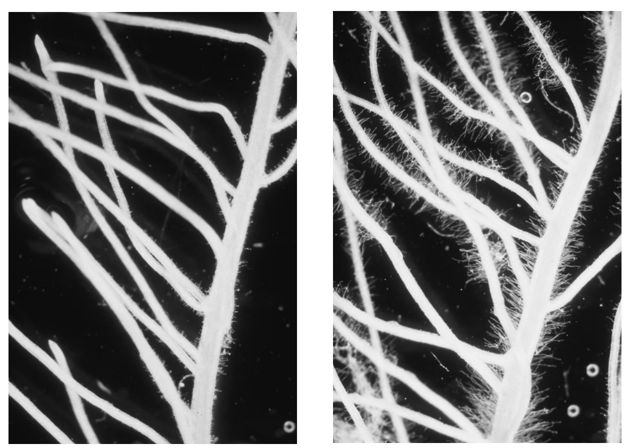
Crop Responses to AmiSorb in the North Central Region

NCR-103 Committee [1], K.A. Kelling, Editor [2]

Abstract

Originally used to prevent scale in boilers, carpramid or thermal polyaspartate (copoly[(3-carboxypropionamide)(2-carboxylmethyl) acetamide)] was brought to agriculture under the trade names AmiSorb and Magnet. It claimed to increase nutrient uptake through artificially increasing the volume of soil occupied by roots through increased root branching and root hair development. Under controlled hydroponic or greenhouse conditions, the use of carpramid increased nutrient uptake, some yield determining factors such as wheat tillering and in some cases, crop yield. Extensive field testing from 1996 to 1998 under various nutrient regimes, placements, forms, and timings resulted in very inconsistent performance. Averaged across all experiments for which data were available, small yield increases were observed for corn (+1.75 bushels/acre), soybean (+0.63 bushel/acre), wheat (+1.07 bushels/acre), and grain sorghum (+0.32 bushel/acre), but at best only about one-fourth of the experiments (27 percent for corn and wheat) showed statistically significant yield increases. Across all crops, only three experiments showed an economic advantage to using carpramid. An attempt was made to better define the conditions when responses were observed but no clear pattern emerged that would allow improved probability of predicting a positive response.

In the mid-1990s, AmiSorb, a high molecular weight polyaspartic acid (carpramid), was introduced to agriculture by AmiLar International, Chicago, Illinois, as a soil additive to enhance nutrient uptake and increase crop yield. The compound was originally used to prevent scale in boilers and heat exchangers and is chemically related to aspartame, commonly marketed as NutraSweet. Industrial uses also include being a component of adhesives, shampoos, super absorbents, and dispersants. The suggested mode of action for AmiSorb is increased nutrient uptake through artificially increasing the area occupied by roots resulting from increased root branching and root hair development. The company suggests that this results in higher crop yield and improved crop quality. Recommended rates are 1 to 2 quarts/acre mixed with liquid fertilizer, impregnated on dry fertilizer, or applied directly to the soil. Retail cost of these treatments is about $15-30/acre.



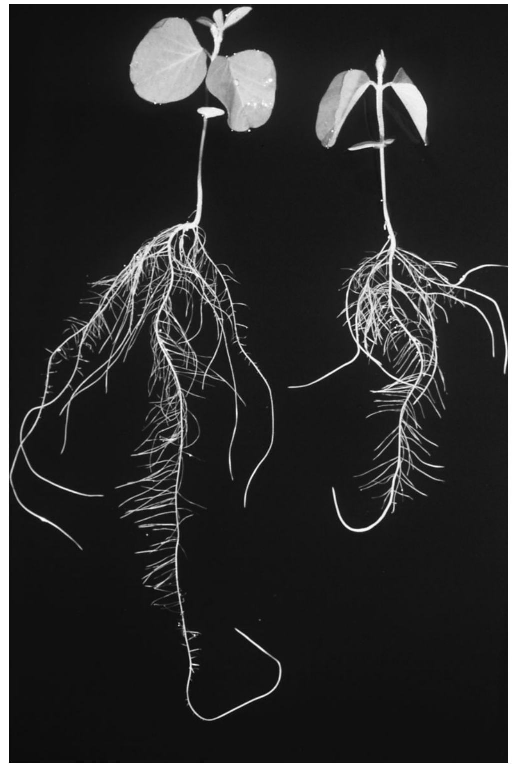
Magnified view shows root hairs on young wheat plants grown with low nutrients either without (left) or with (right) polyaspartic acid. (Photo courtesy of F.E. Below, University of Illinois)

The purpose ot this publication is to summarize recent research on the use of Amisorb with agronomic crops to help farmers decide where and how this product might fit into their fertilization program.

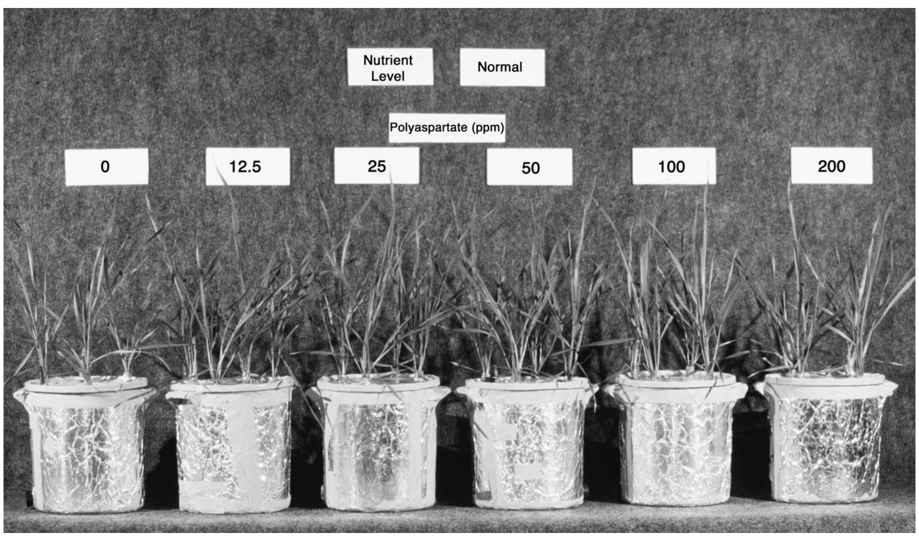
2/ Professor and Extension Soil Scientist, Department of Soil Science, University of Wisconsin- Madison.

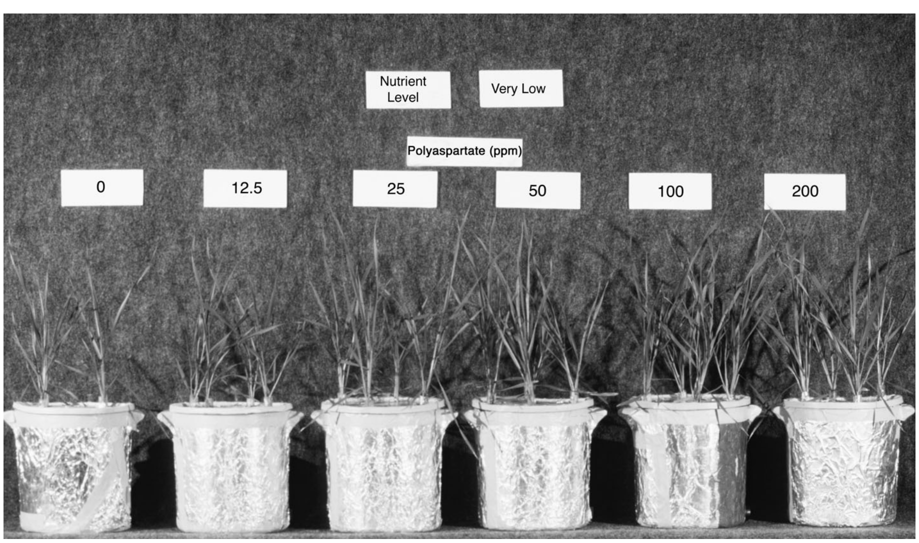
Controlled Environment Experiments

Early research in hydroponic experiments showed that the addition of polyaspartic acid could increase the uptake of some nutrients (N, K, Ca, Mg, Mn, and Zn) by wheat, especially if the nutrient supply was relatively low (Below and Wang, 1995). As shown in Figure 1, increased levels of polyaspartic acid also stimulated wheat tillering, presumably due to the increased nutrient uptake. This, in turn, was expected to increase crop yield (Below and Wang, 1995). The increase in tiller number from the addition of polyaspartic acid was most apparent at low nutrient concentrations, and the increase was proportional to the amount of polyaspartic acid applied. Below and Wang (1995) also directly increased the yield of hydroponically grown duckweed by adding polyaspartic acid, with the magnitude of the increase proportional to the level of nutrient stress present (Figure 2).



Above: *Young soybean plants grown with a low nutrient supply either with (left) or without (right) polyaspartic acid.*





At left: *The wheat plants in both photos show the effect of very low and normal levels of nutrients with varying levels of polyaspartic acid. In both photos, the rows of plants show the result of a progressively increased amount of polyaspartic acid (leftmost plants received none, rightmost plants received the most). The increase in tillering from the addition of polyaspartic acid was more apparent at very low nutrient levels (bottom photo) than at normal nutrient levels (top photo). See corresponding data in Figure 1.*

(Photos courtesy of F.E. Below, University of Illinois)

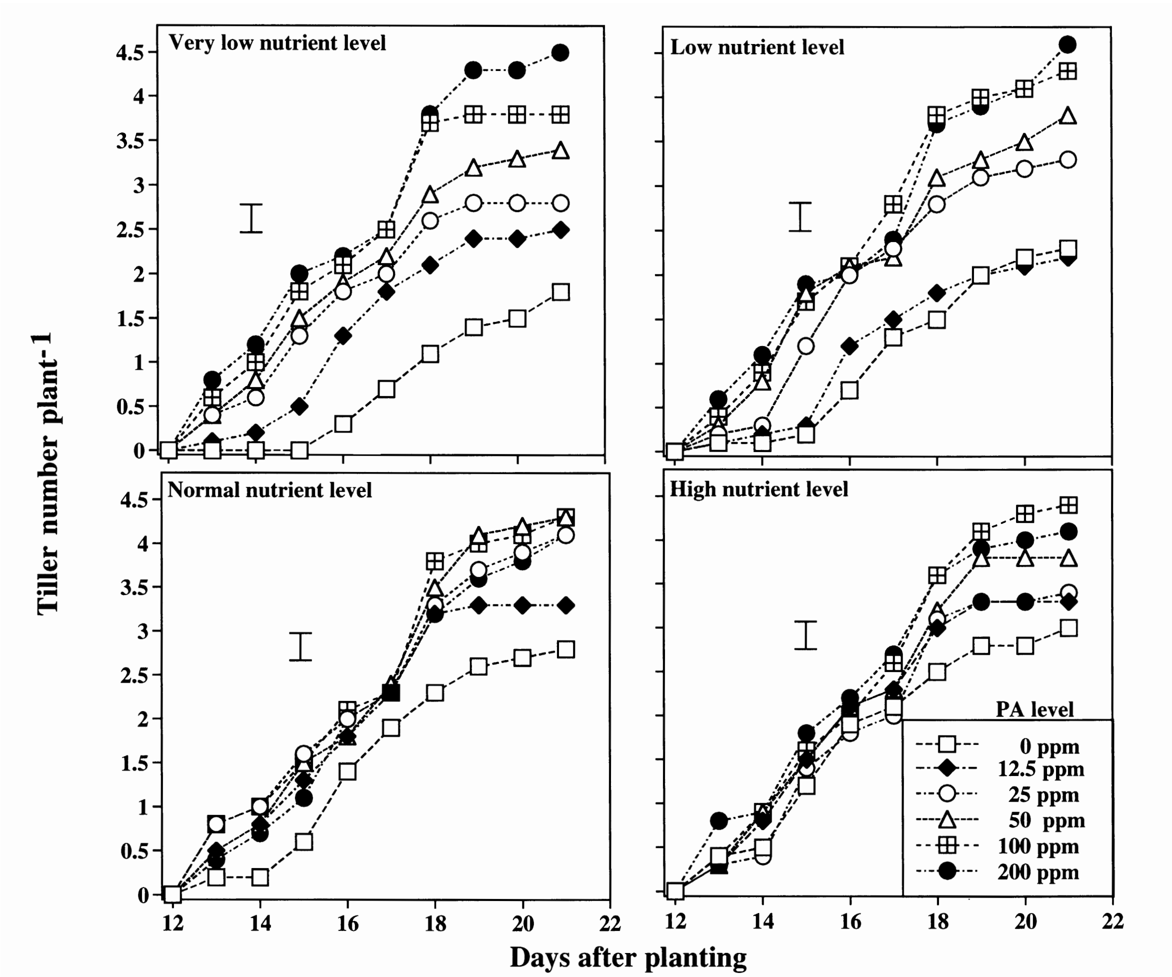


Figure 1. Tillering of wheat as influenced by macronutrient supply and concentration of the synthetic polypeptide, polyaspartic acid (PA) (Adapted from Below and Wang, 1995)

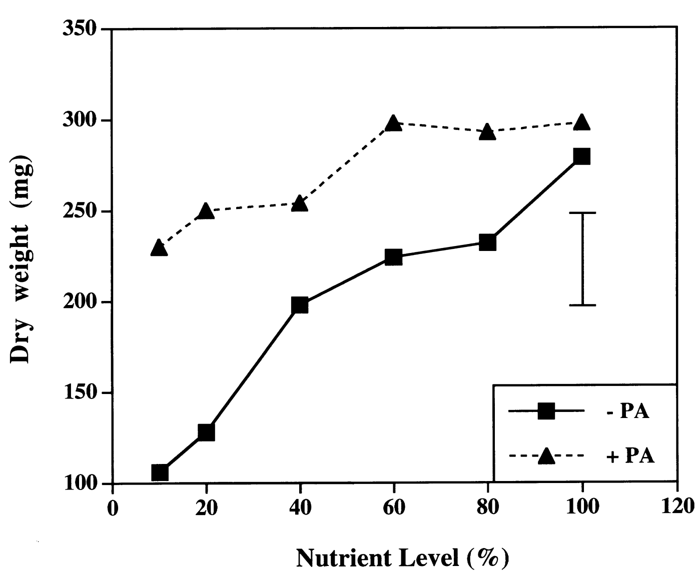


Figure 2. Effect of varying levels of macronutrient supply with or without the synthetic polypeptide, polyaspartic acid (PA) on growth of duckweed plants (Below and Wang, 1995).

Field Research

Yields:

During 1995-1998, a significant amount of field research using polyaspartic acid was conducted throughout the U.S. on corn, soybean, wheat, and grain sorghum. In addition, a smaller number of studies have been conducted on other crops, including bromegrass, cotton and some vegetables. This research often included various AmiSorb rates or placements across multiple varieties and/or fertilizer levels. Results of this research were mixed. For example, Ebelhar (1997) applied 2 quarts/acre of polyaspartic acid either between or under the corn rows at Dixon Springs, Illinois, across several rates of applied fertilizer nitrogen. Although the corn clearly responded to applied N, the addition of polyaspartic acid did not improve grain yield with either method of placement (Table 1). Other Illinois experiments, however, such as those conducted by Below in 1996, showed that two of three corn hybrids at Champaign responded to AmiSorb, especially when applied between the row (Table 2). In other experiments conducted in the same year, Below found no statistically significant yield increases when AmiSorb was applied with three fertilizer sources at nine other locations (F. Below 1996, personal communication). Soil test P and K levels, where Below observed the yield increases, were generally quite high (41 lb/acre Bray P_1 and 261 lb/acre exchangeable K). This argues against the expectation that responses might be more likely where nutrients are in short supply.

Many of the experiments included various fertilizer rates (especially N), fertilizer sources, and times or place of application. However, no clear pattern was evident from the data evaluated as to the conditions or specifics of application that would or would not result in a significant yield response for corn or the other crops evaluated.

Table 3 shows a summary of the results of almost 100 site years of yield data for corn, soybean, wheat, and grain sorghum where the addition of AmiSorb was tested. Data to construct this table were provided by colleagues primarily from the North Central Region or from AmiLar in the form of published and unpublished research reports. A complete listing of these reports is provided as literature cited. Although yield increases were observed in about 27 percent of the corn and wheat experiments, the overall yield change from the addition of AmiSorb remained relatively small. Average responses to AmiSorb application in the various corn experiments ranged from -8.1 bu/acre to +13.6 bu/acre, although some individual treatments within an experiment responded more dramatically. Wheat responses ranged from -5.7 to +4.6 bu/acre.

Average responses to AmiSorb application in the various corn experiments ranged from -8.1 bu/acre to +13.6 bu/acre, although some individual treatments within an experiment responded more dramatically.

(Photo courtesy J. Lauer, University of Wisconsin-Madison.)

Table 1. Effect of AmiSorb on corn grain yield at Dixon Springs, IL, 1996.†

	Between rows		Under rows	
N rate	-AmiSorb	+AmiSorb	-AmiSorb	+AmiSorb
lb/acre	bu/acre			
60	104	117	112	119
120	130	134	141	134
180	138	124	130	133
$LSD_{0.10}$	NS		NS	

† Adapted from Ebelhar (1997).

Table 2. Effect of method of AmiSorb application on grain yield of three corn hybrids at Champaign, IL in 1996.†

	Hybrid		
AmiSorb application‡	A	B	C
	bu/acre		
No AmiSorb	140	135	128
Over the row	142	141	140
Between row/on surface	147	150	150
Between row/incorporated	146	149	154

† Adapted from F. Below (personal communication, 1996).
‡ LSD (0.05)=9.9 (for comparison between any two numbers); AmiSorb applied at 2 quarts/acre..

Table 3. Summary of AmiSorb yield responses for several crops, 1995-1998. †

	Corn	Soybean	Wheat	Grain sorghum
Number of site years	33	10	49	6
Number site years with significant response	9	1	13	1
Percent site years with significant response	27	10	27	17
Average yield change with AmiSorb (bu/acre); all sites included	+1.75	+0.63	+1.07	+0.32

†Data include all results provided through 23 November 1998; many were provided in the form of unpublished research reports.

Nutrient concentration or uptake:

Several of the yield experiments discussed previously also reported the influence of the AmiSorb addition on plant nutrient concentration or nutrient uptake. Of the seven site-years where these data were reported for wheat, only one showed an increase in tissue K levels due to AmiSorb and none for N or P. About half of the nine corn or grain sorghum studies where nutrient concentration data were reported actually showed some increases in tissue N and/or P with AmiSorb. Tissue K levels were generally not reported. No improvements in macronutrient tissue levels were reported in the three soybean studies that included these data.

Although company literature suggests that AmiSorb improves the capability of the plant to take up nutrients, and it has been shown to do so under controlled-environment conditions, these field studies do not show tissue nutrient level increases any more frequently than they did yield increases. It would be expected that if the causative mode of action was correctly identified as being able to enhance nutrient uptake these tissue increases might be more consistent.

Summary

The addition of AmiSorb in hydroponic conditions resulted in increased nutrient uptake, crop yield, and some yield determining factors such as wheat tillering. However, when AmiSorb was tested in a variety of nutrient regimes, placements, forms, and timings under field conditions, the results were inconsistent. When averaged across all experiments, small yield increases were observed for corn (+1.75 bu/acre), soybean (+0.63 bu/acre), wheat (+1.07 bu/acre), and grain sorghum (+0.32 bu/acre), but only about one-fourth (27 percent) of the corn and wheat experiments showed statistically significant yield increases. Results for soybean and grain sorghum were less encouraging. Across all crops, only three experiments showed an economic advantage to using AmiSorb. An examination of the conditions when responses were observed did not result in a clear pattern that would allow improved predictability for response.

Nonconventional additives have been marketed for use in crop production for many years, and to date, most have not demonstrated an economic benefit to farmers especially with agronomic crops. As with all farm products, it is important that farmers: (1) understand the soil, crop, and cropping circumstances for which the product is recommended; (2) be given the specific directions for product use, including precautions; (3) obtain an adequate description of what the product does, including its mode of action and expected nature of the crop response; and (4) be provided the results of research findings preferably under the same conditions that exist on their farm. We suggest these same tests be applied when considering the use of AmiSorb. We recommend that caution be exercised.

References

Below, F.E. 1996a. Effect of adding AmiSorb to various liquid starters. Agronomy Department, Univ. of Illinois.Unpublished research report.

Below, F.E. 1996b. Effects of AmiSorb nutrient absorption enhancer on corn. Agronomy Department, Univ. of Illinois. Unpublished research report.

Below, F.E. 1998. Effect of AmiSorb on yield response of corn. Agronomy Department, Univ. of Illinois. Unpublished research report.

Below, F.E., and X.T. Wang. 1995. Use of polyaspartic acid to improve fertilizer use by plants. Agronomy Department, Univ. of Illinois. Unpublished research report.

Blevins, D. 1996. AmiSorb effects on soybean under field and greenhouse conditions. Agronomy Department, Univ. of Missouri. Unpublished research report.

Bly, A., H. Woodward, and D. Winther. 1997. Influence of AmiSorb fertilizer additive on hard red winter wheat, hard red spring wheat, and corn during 1997. p. 1-6. In South Dakota State Univ., *Soil/Water 1997 Progress Rep.* Soil PR-97-25.

Duncan, S.R., R.E. Lamond, D.A. Whitney, V.L. Martin, G. McCormack, and L. Kater. 1997. Hard red winter wheat response to sulfur fertilization and AmiSorb. p. 13-14. In *1997 Kansas Fertilizer Research Report of Progress 800.*

Ebelhar, S.A. 1996. Nitrogen source, rate, placement and AmiSorb effects on no-till corn grain yields at Dixon Springs. Agronomy Department, Univ. of Illinois. Unpublished research report.

Ebelhar, S.A., and E.C. Varsa. 1996. AmiSorb effects on wheat in South Illinois. Agronomy Department, Univ. of Illinois. Unpublished research report.

Evers, G.W. 1999. Influence of AmiSorb on coastal bermuda grass growth and nutrient uptake. *J. Prod. Agric.* 12:440-444.

Goos, J. 1996. Effects of AmiSorb nutrient absorption enhancers on the yield of hard red spring wheat. Department of Soil Science, North Dakota State Univ. Unpublished research report.

Gordon, W.B. 1996. AmiSorb evaluation for corn and grain sorghum production. p. 57-58. In *1996 Kansas Fertilizer Research Report of Progress 778*.

Gordon, W.B. 1997. Evaluation of AmiSorb for corn and grain sorghum. p. 64-65. In *1997 Kansas Fertilizer Research Report of Progress 800*.

Johnson, J. 1997. Effect of AmiSorb and tillage on soybean yields. School of Natural Resources, Ohio State Univ. Unpublished research report.

Lamond, R.E., M.A. Davied, and D.D. Roberson. 1997a. Evaluation of nitrogen rates and AmiSorb on bromegrass. p. 23-24. In *1997 Kansas Fertilizer Research Report of Progress 800*.

Lamond, R.E., M.A. Davied, D.D. Roberson, V.L. Martin, and T. Maxwell. 1997b. Evaluation of AmiSorb on wheat. p. 9-12. In *1997 Kansas Fertilizer Research Report of Progress 800*.

Lamond, R.E., T. Wesley, D.A. Whitney, V.L. Martin, and S.R. Duncan. 1996. Late-season nitrogen and AmiSorb application on irrigated soybeans with high yield potential. p. 101-102. In *1996 Kansas Fertilizer Research Report of Progress 800*.

Lukina, E.V., W.R. Raun, and G.V. Johnson. 1997. Effect of AmiSorb and MPACT on wheat grain yield. p. 332-334. In *1997 Soil Fertility Research Report*, Oklahoma State Univ.

Mulford, R. 1996. AmiSorb effects on corn yields. Poplar Hill Research Facility, Univ. of Maryland. Unpublished research report.

Murdock, L.W., J. Berbek, and J. James. 1998. AmiSorb effect on corn. p. 49. In *1998 Agronomy Research Progress Report 402*, Univ. of Kentucky.

Oplinger, E.S., and J.M. Gaska. 1997. Effect of AmiSorb on growth and yield of winter wheat. Agronomy Department, Univ. of Wisconsin-Madison. Unpublished research report.

Oplinger, E.S., J.J. Martinka, and J.M. Gaska. 1997a. Effect of liquid and dry formulations of AmiSorb (PAA) on corn plant andgrain yield, Arlington and Hancock. Agronomy Department, Univ. of Wisconsin-Madison. Unpublished research report.

Oplinger, E.S., J.J. Martinka, and J.M. Gaska. 1997b. Effect of liquid and dry formulations of AmiSorb (PAA) on soybean plant and grain yield, Arlington and Hancock. Agronomy Department, Univ. of Wisconsin-Madison. Unpublished research report.

Rankin, M. 1997. Corn starter fertilizer/AmiSorb study. Fond du Lac Co., Univ. of Wisconsin- Extension. Unpublished research report.

Rehm, G. 1997a. AmiSorb in Minnesota. *Crops & Soils Newsletter* 2/1497. p. 2-3.

Rehm, G. 1997b. Effect of AmiSorb on corn at two locations. Dept. of Soil, Water and Climate, Univ. of Minnesota. Unpublished research report.

Sweeney, D.W., and M.B. Kirkham. 1997. Effect of polyaspartate on fertilizer-use efficiency of no-till grain sorghum. p. 61-63. In *1997 Kansas Fertilizer Research Report of Progress 800*.

Thompson, C.A. 1995. Kansas wheat study at Hays, Kansas. Agric. Research Center-Hays, Kansas State Univ. Unpublished research report.

Thompson, C.A. 1996. Response of winter wheat and grain sorghum to rate and method of AmiSorb application soybeans. p. 29-36. In *1996 Kansas Fertilizer Research Report of Progress 778*.

Thompson, C.A. 1998. Effects of AmiSorb on 1998 winter wheat. Agric. Research Center-Hayes, Kansas State Univ. Unpublished research report.

Whitney, D.A., W.B. Gordon, and R.E. Lamond. 1996. Nitrogen, Nutrition Plus and AmiSorb use on irrigated soybeans. p. 108-110. In *1996 Kansas Fertilizer Research Report of Progress 778*.

Woodard, H.J., A. Bly, and D. Winther. 1996. The effect of AmiSorb applications on growth and yield parameters of corn, soybean and hard red spring wheat in eastern South Dakota. p. 1-6. In South Dakota State Univ. *Soil/Water 1997 Progress Report*, Soil PR 97-25.

Crop Responses to AmiSorb in the North Central Region

North Central Regional Research Report 347