Azospirillum
Why Azospirillum?

Azospirillum is a naturally occurring soil bacteria that stimulates root development.

Azospirillum also captures atmospheric nitrogen and converts it to a form of nitrogen that can be used by plants. It is then passed directly to the plant.
The Bacterium 
Azospirillum

• Naturally occurring

• Found on many plant species

• Close to the roots (Rhizoplane) and attached to the roots

• Not a nodulater
History

• The first species of the genus, originally named *Spirillum lipoferum*, was isolated from soil in the Netherlands in 1925. Forgotten for half a century, *Azospirillum* was 'rediscovered' in the 1970s during a search for associative nitrogen fixers in the rhizosphere of *Digitaria* and *Zea mays* in Brazil. Since then, isolation of azospirilla from roots of numerous wild and cultivated plants and from different soil types has been reported from all over the world.
To date 7 species have been identified within the genus *Azospirillum*

- *A. brasilense*
- *A. lipoferum*
- *A. amazonense*
- *A. halopraeferans*
- *A. irakense*
- *A. largimobile*
- *A. doebereineriae*
Azospirillum Colonization

• The first step (the adsorption step), consists of a rapid, loose, and reversible binding of *Azospirillum* to the root.

• The second step (the anchoring phase), the bacteria become irreversibly bound to the root surface.
Where?

- During the first days of the association, *Azospirillum* specifically colonizes the sites of lateral root emergence and the root hair zones of the primary as well as the secondary roots.
Azospirillum and root interaction, E = Zone of elongation, RH = Root Hairs
RH = Root Hair, RS = Root Surface, B = Unattached Azospirillum Bacteria
Bacterial Attachment

RS = Root Surface
B = Attached Azospirillum Bacteria
Bacterial Attachment

RH = Root Hair, RS = Root Surface, B = Attached Azospirillum Bacteria
TAZO®

Azospirillum Grass Seed Innoculant

From TerraMax, Inc.
How is **TAZO®** Different?

**TAZO®** uses an advanced stabilization technology that keeps more bacteria viable so consumers receive more benefit. Packaged **TAZO®** remains viable for over one year. **TAZO®** has been shown to be viable on seed for one year.
Bacteria can be sensitive to environmental conditions like pH, heat and moisture. Unprotected from these elements, they may die before they are applied or benefit the crop. Not so with TAZO®

In A Word - SURVIVAL
TAZO® Products

Formulations

- TAZO-ST Dry - Powder Seed treatment
- TAZO-B – Broadcast spray
- TAZO-ST Liquid – Liquid Seed treatment
TAZO® Products

Use Rates

• TAZO-ST Dry – 1% by wt of seed

• TAZO-B – 8 fluid ounces per 10,000 square feet
TAZO® Products

Directions for Use

• TAZO-ST Dry – Mix thoroughly with seed till evenly coated

• TAZO-B – Spray over surface to be treated and water in.
TerraMax has developed a seed treatment product that can be used to deliver microorganisms. This is applied as a powder directly on the seed.

**Description**

Kentucky Bluegrass seed was treated and planted in a soil mixture. The plants were raised under fluorescent lights and watered together as needed. Root volumes were measured six weeks after planting.

**Treatment**

**Product:** **TAZO** ST Dry

**Application rate:** 1% by weight of seed
Athletic Field

• The next five slides represent work done by the Glen Rehbein Companies at an athletic field installation for a school in Minneapolis. Supervised by Mike Kelly. The product used was the TAZO®-ST Dry.
North side of field

2 box planter came down and turned around for two passes
untreated strips are side by side
TAZO® Non Treated vs Treated
TAZO® Non-Treated vs. Treated

Untreated Infield – Breck Bluegrass Rye mix 14 DAP

T-AZO Treated 1% w/w Infield – Breck Bluegrass Rye mix 14 DAP
University Trials

1) Growth parameters

   a) U of N Lincoln – Gaussoin 2006 – Statistically significant root growth

   b) Iowa State – Hoiberg 2011 – Maintained color quality at reduced fertilizer rates with TAZO®

2) Nitrogen fixation

   a) U of MN – Horgan 2008 – Via Total Kjeldahl showed more N in treated.

   b) U of N Lincoln – Gaussoin 2011 – N^{15} ratio showed statistically more “fixed” N in treated

   c) U of Wisconsin – Soldat 2011 – N^{15} ratio showed statistically more “fixed” N in treated
**Evaluation of N-Fixer on Low Maintenance Kentucky Bluegrass**

2011

Treatments had a significant effect on the $\delta^{15}N$ value of the tissue compared to the non-treated control, indicating that a substantial portion (12-32%) of the nitrogen was derived from the atmosphere.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Application Rate</th>
<th>$\delta^{15}N$</th>
<th>% of N fixed*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium sulfate (CaSO$_4$)</td>
<td>6.0 lbs/M</td>
<td>2.76 BC</td>
<td>20.9</td>
</tr>
<tr>
<td>Calcium sulfate (CaSO$_4$)</td>
<td>10.0 lbs/M</td>
<td>3.07 AB</td>
<td>12.0</td>
</tr>
<tr>
<td>Free &amp; Green Contains TAZO</td>
<td>6.0 lbs/M</td>
<td>2.41 C</td>
<td>30.9</td>
</tr>
<tr>
<td>Free &amp; Green Contains TAZO</td>
<td>10.0 lbs/M</td>
<td>2.39 C</td>
<td>31.5</td>
</tr>
<tr>
<td>TAZO®-B</td>
<td>0.8 oz/M</td>
<td>2.59 BC</td>
<td>25.8</td>
</tr>
<tr>
<td>Non-treated Control</td>
<td>N/A</td>
<td>3.49 A</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Average tissue nutrient content from eight clipping sampling dates. Means with different letters within columns are not statistically different according to Fisher’s LSD at the alpha=0.05 level.

Doug Soldat
Dept. of Soil Science, University of Wisconsin-Madison
Investigation of TAZO-B liquid treatment on Kentucky bluegrass
Andrew Hoiberg, Dave Minner
Iowa State University

1) 1 lb Urea (46-0-0) / 1000 ft² – 4 apps
   – 6 July, 15 August, 1 October, 15 March
2) 1 lb Scott’s 18-9-18 Slow Release / 1000 ft² – 4 apps
   – 6 July, 15 August, 1 October, 15 March
3) TAZO @ 0.8 oz/1000 ft² – 2 apps
   – 6 July, 17 August
4) TAZO @ 0.8 oz/1000 ft² – 2 apps + 1 lb
   Urea/1000 ft² – 2 apps
   – 6 July, 17 August for Tazo
   – 6 July, 1 September for Urea
5) TAZO @ 0.8 oz/1000 ft² – 2 apps + 1 lb 18-9-18 SR/1000 ft² – 2 apps
   – 6 July, 17 August
   – 6 July, 1 September for 18-9-18 SR
6) TAZO @ 0.8 oz/1000 ft² – 4 apps
   – 6 July, 27 July, 17 August, 7 September
7) Untreated control

Treatment effects on turfgrass color ratings, averaged over nine sampling dates in summer and fall 2011. Least significant difference bars are shown for each treatment. Where a bar overlaps a mean, no difference exists.
University Nebraska Lincoln
Conducted by Roch Gaussoin

- Root mass increase statistically significant
- Top growth improved
- Bluegrass was used
- Other sources confirm similar results on other grasses
**University of Nebraska Lincoln – 2006 Roch Gaussoin**
**Planted May 1 – Harvested August 24**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Root Dry Weight (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Seed Coated 1X</td>
<td>0.44 ab</td>
</tr>
<tr>
<td>Dry Seed Coated 2X</td>
<td>0.30 bc</td>
</tr>
<tr>
<td>Liquid Seed Coated 1X</td>
<td>0.54 a</td>
</tr>
<tr>
<td>Liquid Seed Coated 2X</td>
<td>0.29 bc</td>
</tr>
<tr>
<td>Liquid at planting 1X</td>
<td>0.42 ab</td>
</tr>
<tr>
<td>Liquid at planting 2X</td>
<td>0.31 bc</td>
</tr>
<tr>
<td>Control</td>
<td>0.26 c</td>
</tr>
<tr>
<td>LSD (0.10)</td>
<td>0.16</td>
</tr>
</tbody>
</table>
TAZO DRY seed treatment gave a 69% increase in rooting
TAZO Liquid seed treatment gave a 108% increase in rooting

University of Nebraska Lincoln – 2006 Roch Gauvsoin
Broadcast TAZO B treatment resulted in a 62% increase in root growth.
Municipal Soccer Fields
Becker, MN 2008

- Seed Treated with TAZO®-ST Dry 1% by weight
- 80% Bluegrass 20% Ryegrass mix
- Seed treated by Specialty Turf & Ag
- 4 acres treated, 3 acres untreated side by side
- 500 Pounds / Ac of 8-12-6 starter fertilizer applied before planting
- 300 pounds / AC 17-9-7 21 Days After Planting (DAP)
- Photos are 28 DAP
- Personal observation more bluegrass was germinated in treated area
Treated
TAZO®-ST Dry

Untreated
“I have reduced my Nitrogen inputs by 50 to 30 % depending on which part of the golf course. I get better color and disease resistance. I space my pesticide applications a few extra days.”

Dan Wolner  Superintendent  Lake Panorama  National Golf Course- Iowa
Panorama National 2007 – Panora, IA
TAZO™ Broadcast Treated
No additional nitrogen was applied

First Fairway

Eighteenth Fairway
This experiment was done with TAZO®- ST Dry treated perennial ryegrass. Planted into a sand based medium on May 15 and harvested August 21, 2009. The plants were irregularly watered by rain and irrigation to induce some drought stress.
Turf production

Field planted November 2009 – Treated with TAZO® September 2010 Harvested October 2010. Blaine, MN
City athletic complex

Customer commented that he was able to take $40/acre out of his Nitrogen budget and incorporate TAZO-B. This yielded fields that were not destroyed in the center of the field. He had the same budget and much better fields. These pictures were taken on August 25th after their spring and summer programs.

2nd year of using TAZO®-B on tight city budget
Field was overseeded with Tazo®-ST Dry treated seed.
4 month old bentgrass sod field
MN Golf Green Mid July - Bentgrass
Warm season Grasses
TAZO-B treated Bermuda Sod

Harvested Sod

Regrowth after 25 days
Phoenix Sports Field
Native soil & sand Mix
better roots and more wear tolerance
Bermuda TAZO-B
California 2012

Treated

Untreated