Boron, an essential plant nutrient
Boron is one of seven micronutrients essential to all plant growth. Its role was recognized first in the 1920s and since that time, boron deficiency has been recognized in a wide range of crops.

Correcting boron deficiency
Boron deficiency can be remedied by the correct application of a borate containing material in solid or liquid fertilizers, to the seedbed in annual crops or under the foliar canopy of perennial crops.

Blended fertilizers
One very common and practical field method is to blend a suitable boron granule containing the base fertilizer or top dressing. The blend is then applied to the crop in the normal way. Granubor® is particularly suitable for this purpose.

Detecting boron deficiency
Boron deficiency shows in clearly defined ways in certain crops. Generally, by the time visible symptoms are seen, yields will already have been adversely affected. The best way to establish need is either through soil testing or through tissue analysis. In this way, boron supplementation can form part of a ‘balanced nutrition’ approach to crop fertilization.

Predicting boron deficiency
Certain crops world-wide are known to be more susceptible to lack of boron than others. These are shown in the tables.

There are several factors which need to be taken into account when boron deficiency may be suspected:
- High rainfall
- Recent liming (pH over 6.6)
- Previous cropping
- Boron removal by previous crops
- No boron nutrition
- Sandy soils
- High organic matter

<table>
<thead>
<tr>
<th>Susceptible to B deficiency</th>
<th>Moderately susceptible to B deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa (Lucerne)</td>
<td>Banana</td>
</tr>
<tr>
<td>Apple</td>
<td>Cocoa</td>
</tr>
<tr>
<td>Broccoli</td>
<td>Flax linseed</td>
</tr>
<tr>
<td>Carnation</td>
<td>Hop</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>Maize Corn</td>
</tr>
<tr>
<td>Carrot</td>
<td>Olive</td>
</tr>
<tr>
<td>Celery</td>
<td>Papaya</td>
</tr>
<tr>
<td>Chrysanthemum</td>
<td>Turnip</td>
</tr>
<tr>
<td></td>
<td>Coconut</td>
</tr>
<tr>
<td></td>
<td>Hop</td>
</tr>
<tr>
<td></td>
<td>Maize Corn</td>
</tr>
<tr>
<td></td>
<td>Olive</td>
</tr>
<tr>
<td></td>
<td>Tomato</td>
</tr>
</tbody>
</table>
Additional reading

*Boron Deficiency—Its Prevention and Cure*, by V.M. Shorrocks
(available from U.S. Borax on request.)

*Mineral Nutrition of Higher Plants*, by Horst Marschner,
Academic Press.

*Boron and its Role in Crop Production*, by Umesh C. Gupta. CRC Press.

Advantages of Granubor

A natural product

Granubor is produced solely from sodium tetraborate pentahydrate which is itself refined from tincal ore using only physical means: crushing, steam, water, settling and crystallization. Granubor contains no impurities or added ingredients, filters or coatings.

A sodium borate

Granubor is a sodium borate, totally soluble and the most appropriate form to provide boron in a soil solution in a timely manner for annual and perennial crops.

Perfect for blending – compatibility with a wide range of fertilizers

A number of factors affect quality of mixing of fertilizers ingredients when they are blended together such as particle size, weight/density and surface characteristics. By far the most important one is the average size of the granules and how similar this is to the average granule size of the other ingredients in the blend.

Granubor has an average particle size of around 2.8 mm, making it compatible with most fertilizers with a minimum of segregation in bagging, transport and application.

Perfect for blending – particle size distribution

The particle size distribution is also important in terms of compatibility. Granubor is screened between -4 and +14 mesh with very little outside these values, and has a uniform particle size distribution similar to commonly used blends of prilled and granulated fertilizers. The graph below shows the typical product “fit” with two typical blends.

While the mean particle size is important, so are the variation particle sizes within the product or the particle spread. Particle spread can be visualized in the graphs below in which Granubor is shown against the two fertilizer blends.

Granubor closely approximates the particle size spread of two example blends. Some competitors do not.

The figure below shows how the average particle size of Granubor compares with 12 example fertilizers:
**Product Data Sheet**

**Granubor®**

**Typical particle size**

<table>
<thead>
<tr>
<th>SGN</th>
<th>Ul</th>
<th>Va</th>
</tr>
</thead>
<tbody>
<tr>
<td>280</td>
<td>50</td>
<td>20</td>
</tr>
</tbody>
</table>

*Definitions:*
- SGN = $d_{50} \times 100$ (Materials having SGNs within 10% of other components' SGNs mix well.)
- Ul = $d_{5}/d_{90} \times 100$ (A measure of particle size spread. The higher the value, the tighter the distribution.)
- Va = $(d_{84}-d_{16})^2 \times d_{50} \times 100$ (Variation Index. The higher the value, the greater the deviation from the $d_{50}$)

**Sieve specification**

<table>
<thead>
<tr>
<th>U.S. Standard Sieve No.</th>
<th>% Retained Guarantee</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4 + 14</td>
<td>≥95.0</td>
</tr>
</tbody>
</table>

**In transport and storage**

**Crush resistance**

Granubor will resist breakage in normal transport and handling and during spreading.

**Conditioning or coating to prevent attrition and dust**

The attrition (breakage) of particles producing fines and powder can be most important in handling and transport.

**Typical particle strength**

| 9 lbs/granule | Force required to crush particles with an average diameter of 2.4mm. |

**Bulk density**

<table>
<thead>
<tr>
<th>kg/m³</th>
<th>lb/cu ft.</th>
<th>Angle of repose</th>
</tr>
</thead>
<tbody>
<tr>
<td>942.5</td>
<td>58.84</td>
<td>30°</td>
</tr>
</tbody>
</table>

**Typical flow rate**

Granubor can be pneumatically transported, tipped and conveyed.

| 11 lbs/min | Measurement according to fertilizer industry standard EN 1235:1995. |
Granubor is specially surface treated with borate to reduce the possibility of degradation and dust content. In the graph at the right Granubor and some competitors have been compared in terms these parameters. Results in the lower left quadrant are most acceptable.

Main uses

- Incorporation of boron into blended fertilizers to provide an application ready mixture Granubor is a white granular boron material produced to meet the stringent requirements of the bulk blended fertilizer industry
- Direct application by farmers where its physical form may present advantages in application, eg case of spreading under and around tree and plantation crops
- Granubor has been developed to improve the soil boron status when this is low or borderline (ie less than 0.5ppm) hot water available boron level
- To calculate the amount of Granubor required, multiply the elemental boron by 7.0

The Granubor brand

20 Mule Team® Borax has been providing granular boron for soil applications since 1985. Granubor is the result of further process research and an up-to-date understanding of the market needs.

Notice: Before using these products, please read the Product Specifications, the Safety Data Sheets and any other applicable product literature. The descriptions of potential uses for these products are provided only by way of example. The products are not intended or recommended for any unlawful or prohibited use including, without limitation, any use that would constitute infringement of any applicable patents. Nor is it intended or recommended that the products be used for any described purposes without verification by the user of the products’ safety and efficacy for such purposes, as well as ensuring compliance with all applicable laws, regulations and registration requirements. Suggestions for use of these products are based on data believed to be reliable. The seller shall have no liability resulting from misuse of the products and provides no guarantee, whether expressed or implied, as to the results obtained if the products are not used in accordance with directions or safe practices. The buyer assumes all responsibility, including any injury or damage, resulting from misuse of the product, whether used alone or in combination with other materials. THE SELLER MAKES NO EXPRESS OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. THE SELLER SHALL HAVE NO LIABILITY FOR CONSEQUENTIAL DAMAGES.