THE NACHURS® HIGH YIELD POTATO PROGRAM

PROVIDING POTATO GROWERS PREMIUM LIQUID STARTER AND FOLIAR NUTRIENTS SINCE 1946

www.nachurs.com
INTRODUCTION

Potatoes (Solanum tuberosum) are a herbaceous, perennial nightshade that produces tubers, which are actually thickened stems that are very rich in starch. They rank as the world’s fourth most important food crop, after maize (corn), wheat, and rice. The potato belongs to the botanical family Solanaceae, and shares the genus Solanum with at least 1,000 other species, including tomato and eggplant. Potatoes are a very important crop for many growers in the Pacific Northwest (i.e. Washington State, Oregon). From 2014 USDA reports, growers in this geography planted a total of 210,000 acres of potatoes consisting of russet, gold, red, white, seed potatoes, fresh-market, etc.

There are many ways to fertilize a potato plant in order to increase production. However, in order to achieve productivity and quality to the highest degree, the principles of 4R Nutrient Stewardship Program must be adhered to. This employs using the right fertilizer sources, applied at the right rate so as not to damage the environment, used at the right time and the right place for optimum plant utilization.

POTATO GROWTH AND DEVELOPMENT

Potatoes will grow on most soils, with light/medium texture soils being the preferred choice for ease of harvesting (i.e. mechanical). NACHURS Potato Program is based on a balanced fertility program utilizing preplant (i.e. dry broadcast), at planting (i.e. in-furrow, 2x2) and foliar nutrition applications. Potato growth is classified into five distinct growth phases (Fig. 1), and will vary based on environment, management, and cultivar interactions. These stages of growth will need to be considered when managing water and nutrients for optimum crop growth and development (Fig 2.)

STAGE I: SPROUT DEVELOPMENT
Sprout develops from eyes on seed tubers and grows upward to emerge from the soil. Roots begin to develop at the base of emerging sprouts.

STAGE II: VEGETATIVE GROWTH
Leaves and branch stems develop from aboveground nodes along emerged sprouts. Roots and stolons develop at below-ground nodes. Photosynthesis begins.

STAGE III: TUBER INITIATION
Tubers form at stolon tips but are not yet appreciably enlarging. In most cultivars the end of this stage coincides with early flowering.

STAGE IV: TUBER BULKING
Tuber cells expand with the accumulation of water, nutrients, and carbohydrates. Tubers become the dominant site for deposition of carbohydrates and mobile inorganic nutrients.

STAGE V: MATURATION
Vines turn yellow and lose leaves, photosynthesis decreases, tuber growth slows, and vines eventually die. Tuber dry matter content reaches a maximum and tuber skins set.

Figure 1. Main stages of growth and development of potatoes. The nutritional requirements of the developing potato change during the growing season.
Source: Nutritional Recommendations for Potatoes, Haifa
tuber yield. Leaf area index is the dimensionless ratio of leaf surface area to ground surface area. Growth stage I spans the period of planting to emergence and ranges from 20 to 35 days depending upon varietal differences, cultural practices, and environmental conditions. Growth stage II encompasses early vegetative development from emergence to tuber initiation and ranges from 15 to 25 days depending upon site-specific conditions. Stolons begin to develop during growth stage II, but tubers are not yet present. Tubers form at the tips of the stolons over a 10-to-14-day period, which is called “tuberization” or tuber initiation and represents growth stage III. During this growth stage, the LAI is generally in the range of 1 and 2, which corresponds to 50-80 percent row closure depending upon site-specific conditions and variety.

Tuber enlargement or “bulking” occurs largely throughout growth stage IV. The increase in tuber size is approximately linear with time over a 30-to-60-day period under optimal environmental conditions. Near the end of growth stage IV, LAI reaches a maximum range of 3.5 to 6.0, depending upon variety and environmental conditions (Wright and Stark, 1990). Water use or “transpiration” by the potato plant also reaches a maximum at this time. Near the end of growth stage IV, the growth rate of the canopy begins to decline. During growth stage V, plants begin to die and lose leaves. Tuber growth rates decline as the result of reduced leaf area and photosynthetic activity, and tuber skins begin to mature. The remaining tuber growth results primarily from translocation of plant materials from stem, leaf, and roots to the tubers.

Root System
Potato plant root system development is relatively...

NUTRIENT REQUIREMENTS
A balanced fertility program is essential in achieving maximum potato growth and development for high yield potential. All nutrients are required for optimum performance (Table 1) and are needed at specific growth stages (Fig. 3).

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (N)</td>
<td>Synthesis of proteins for growth</td>
</tr>
<tr>
<td>Phosphorus (P)</td>
<td>Cellular division, formation of energetic structures</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>Transport of sugars, formation of starch, stomata control, co-factor of enzymatic reactions, reduces susceptibility to plant diseases</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>Building block in cell walls, reduces susceptibility to plant diseases</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>Part of chlorophyll molecule</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>Synthesis of essential amino acids</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>Cell wall formation, germination and elongation of pollen tube, metabolism and transport of sugars</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>Influences the metabolism of nitrogen and carbohydrates</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>Chlorophyll synthesis</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>Aides in photosynthesis</td>
</tr>
<tr>
<td>Molybdenum (Mo)</td>
<td>Component of nitrate-reductase and nitrogenase enzymes</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>Auxin synthesis</td>
</tr>
</tbody>
</table>

Table 1. Source: Nutritional Recommendations for Potato, Haifa
High yielding potatoes require a large amount of nutrients at the right time, especially nitrogen and potassium. (Table 2). Regardless of variety (red, chip, white, russet, sweet, etc.), all potatoes generally require the same quantity of nutrients for proper growth and development. Potassium is particularly important for prompt availability, as 60% to 70% of the total uptake occurs between 30 and 60 days after emergence (DAE) with as much as 15-20 pounds per day being required. As with all plants, available and adequate potassium ensures the plants functionality.

<table>
<thead>
<tr>
<th>Tons/ac</th>
<th>N</th>
<th>P₂O₅</th>
<th>K₂O</th>
<th>CaO</th>
<th>MgO</th>
<th>Tons/ac</th>
<th>N</th>
<th>P₂O₅</th>
<th>K₂O</th>
<th>CaO</th>
<th>MgO</th>
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</thead>
<tbody>
<tr>
<td>10</td>
<td>43</td>
<td>20</td>
<td>114</td>
<td>2</td>
<td>2</td>
<td>10</td>
<td>118</td>
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<td>21</td>
</tr>
<tr>
<td>15</td>
<td>64</td>
<td>30</td>
<td>172</td>
<td>3</td>
<td>3</td>
<td>15</td>
<td>177</td>
<td>47</td>
<td>209</td>
<td>49</td>
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</tr>
<tr>
<td>20</td>
<td>85</td>
<td>40</td>
<td>229</td>
<td>4</td>
<td>4</td>
<td>20</td>
<td>235</td>
<td>63</td>
<td>278</td>
<td>65</td>
<td>43</td>
</tr>
<tr>
<td>25</td>
<td>107</td>
<td>50</td>
<td>286</td>
<td>5</td>
<td>5</td>
<td>25</td>
<td>294</td>
<td>78</td>
<td>348</td>
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<td>53</td>
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<tr>
<td>30</td>
<td>128</td>
<td>61</td>
<td>343</td>
<td>6</td>
<td>6</td>
<td>30</td>
<td>353</td>
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<td>417</td>
<td>98</td>
<td>64</td>
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<td>35</td>
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<td>400</td>
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<td>7</td>
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<td>412</td>
<td>110</td>
<td>487</td>
<td>114</td>
<td>75</td>
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<tr>
<td>40</td>
<td>170</td>
<td>81</td>
<td>457</td>
<td>8</td>
<td>8</td>
<td>40</td>
<td>471</td>
<td>126</td>
<td>557</td>
<td>130</td>
<td>85</td>
</tr>
</tbody>
</table>

Table 2. Source: Nutritional Recommendations for Potato, Haifa
The use of NACHURS Bio-K® will also improve tuber size and skin set, which decreases days to harvest and increases net profit per acre.

### 2016 Third Party Potato (chip) Trial Summary*

**In-furrow fertility; NPK alone vs. NPK + K-fuel**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total Yield (cwt/ac)</th>
<th>Grade A</th>
<th>SG</th>
</tr>
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<tbody>
<tr>
<td>NPK alone</td>
<td>353.5</td>
<td>45.21%</td>
<td>1.07515</td>
</tr>
<tr>
<td>NPK + K-fuel</td>
<td>368.4</td>
<td>49.20%</td>
<td>1.07385</td>
</tr>
</tbody>
</table>

*2 replicated trial sites in ME, WA
**Treatment 1 - 10 gal NPK in-furrow
***Treatment 2 - 8 gal NPK + 2 gal Nachurs K-fuel in-furrow

### Solubility of potassium sources  
**(g/100 ml)**

<table>
<thead>
<tr>
<th>Source</th>
<th>Solubility (g/100 ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio-K</td>
<td>255.6</td>
</tr>
<tr>
<td>Potassium hydroxide</td>
<td>121.0</td>
</tr>
<tr>
<td>Potassium carbonate</td>
<td>112.6</td>
</tr>
<tr>
<td>Potassium sulfite</td>
<td>107.0</td>
</tr>
<tr>
<td>Potassium thiosulfate</td>
<td>96.1</td>
</tr>
<tr>
<td>Potassium chloride</td>
<td>34.3</td>
</tr>
<tr>
<td>Potassium nitrate</td>
<td>31.6</td>
</tr>
<tr>
<td>Potassium magnesium sulfate</td>
<td>24.4</td>
</tr>
<tr>
<td>Potassium sulfate</td>
<td>11.1</td>
</tr>
</tbody>
</table>

### Point of deliquescence of potassium sources  
**( % RH)**

<table>
<thead>
<tr>
<th>Source</th>
<th>Deliquescence (% RH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio-K</td>
<td>23.3</td>
</tr>
<tr>
<td>Potassium hydroxide</td>
<td>44.0</td>
</tr>
<tr>
<td>Potassium carbonate</td>
<td>85.0</td>
</tr>
<tr>
<td>Potassium sulfite</td>
<td>93.2</td>
</tr>
<tr>
<td>Potassium thiosulfate</td>
<td>97.2</td>
</tr>
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</table>
NACHURS PRODUCT RECOMMENDATIONS

The following recommendations are intended as a general recommendation for all potato production. Adjustments can be made according to the end use of the crop produced: chips, processing, table stock, storage, or fresh. They will also vary according to geographic location of the production and soil test levels. Additional fertility (nitrogen, phosphate, micronutrients, etc.) can be applied at various crop stages and will vary based on environmental conditions. Consult your local NACHURS or Skagit field consultant.

1. At planting, in-furrow:
   • Apply 2-4 total gal/ac of Rhyzo-Link® 3-10-13 and/or NACHURS Triple Option®, with 1 gal/ac NACHURS K-fuel® and 1 qt/ac NACHURS® 9% Zn EDTA. Other nitrogen and phosphate can be provided as well based on nutrient levels and production goals.

2. At tuber initiation, foliar:
   • Apply 1-2 gal/ac of NACHURS K-fuel® with 1 qt/ac NACHURS Finish Line®. Other nutrients may be included if deemed necessary by tissue analysis.

3. At tuber bulking, foliar:
   • Apply 1-2 gal/ac of NACHURS Triple Option® with 1 qt/ac NACHURS Finish Line®. NACHURS® 10% Boron may be added at 1 pt/ac on thin-skinned varieties to begin sugar translocation process.

4. At maturity, foliar:
   • Depending on fertility levels early at planting, apply 1 gal NACHURS Triple Option® with 1 pt/ac NACHURS® 10% Boron at 21 days before vine kill.

DO NOT apply phosphate containing fertilizers 60 days (russet) or 65 days (thin-skinned) after emergence if generous amounts of fertilizer was placed in-furrow at planting. The only exception would be to alter nitrate levels in the plant/tuber.

2016 Third Party Potato (russet) Trial Summary*
In-furrow fertility + K-fuel + Finish Line

<table>
<thead>
<tr>
<th>Total Yield (bu/ac)</th>
<th>NPK in-furrow**</th>
<th>NPK in-furrow + K-fuel foliar***</th>
<th>NPK in-furrow + K-fuel and Finish Line foliar****</th>
</tr>
</thead>
<tbody>
<tr>
<td>443.1</td>
<td>506.2</td>
<td>528.7</td>
<td></td>
</tr>
</tbody>
</table>

*2 replicated trial sites in ME, WA
**In-furrow - 8 gal NPK in-furrow
***Nachurs K-fuel at 2 gal/ac at 35 days after emergence
****Nachurs Finish Line at 1 qt/ac at 35 days after emergence
OUR LOCATIONS

SKAGIT FARMERS SUPPLY COOPERATIVE
1833 PARK LANE, PO BOX 266
BURLINGTON, WA 98233
TOLL-FREE 888-757-6053
FAX 360-757-4143

AGRONOMY CONWAY
20476 CONWAY FRONTAGE RD.
MOUNT VERNON, WA 98273
360-445-5015

AGRONOMY BURLINGTON
12939 AVON ALLEN RD.
BURLINGTON, WA 98233
360-757-7870

PETROLEUM AND PROPANE
PHONE: 360-757-6053
TOLL-FREE: 888-757-6053
AFTER HOURS EMERGENCY:
360-209-0310

COUNTRY STORE LOCATIONS

1276 S. BURLINGTON BLVD.
BURLINGTON, WA 98233
(360) 757-4055

466 W. 1ST
COLVILLE, WA 99114
(509) 684-2232

6265 N. GOVERNMENT WAY
COEUR D’ALENE, ID 83815
(208) 772-2715

5463 CAMERON ROAD
FREELAND, WA 98249
(360) 331-1970

31686 SR 20
OAK HARBOR, WA 98277
(360) 675-2277

900 RIVERSIDE DRIVE
MOUNT VERNON, WA 98273
(360) 424-4207

915 MOORE ST.
SEDRO-WOOLLEY, WA 98284
(360) 856-6567

10505 N. NEWPORT HWY
SPOKANE, WA 99218
(509) 466-1300

5605 E. SPRAGUE AVE.
SPOKANE VALLEY, WA 99212
(509) 534-1412

14705 E. SPRAGUE AVE.
SPOKANE VALLEY, WA 99216
(509) 926-6603

8815 272ND STREET NW
STANWOOD, WA 98292
(360) 629-7033

3673 EASTSIDE HWY.
STEVENVILLE, MT 59870
(406) 777-5527

1000 23RD AVENUE
OROVILLE, WA 98844
(509) 560-7088