**Background**

Phosphorus is the second most limiting essential nutrient for plant growth. Phosphorus plays an important role in photosynthesis, protein formation, growth, reproduction, and energy transfer. Plants primarily uptake P through roots as orthophosphate (HPO₄²⁻). Phosphate is chemically stable and quickly binds with soil, calcium, aluminum, and iron that makes less available for plant uptake results lower P use efficiency [1]. Foliar application of phosphate fertilizer is not effective due to poor absorbance by the cereal leaves [2]. Phosphate is a compound consists of a phosphorus atom chemically bound to three oxygen atoms. Because of its oxidation state, phosphate is less stable and highly soluble in water. This may help easily absorb by cereal leaves.

**Objective**

The study was designed to assess the effects of foliar phosphate fertilization on growth and yield of corn.

**Method**

- A field trial was initiated in 2011 at Lake Carl Blackwell near Stillwater, Oklahoma, and a greenhouse study at Oklahoma State University in Stillwater, Oklahoma.
- Phosphorus deficient soil was used in both studies. Soil test Mehlich 3 P value at LCB and the greenhouse were 20 ppm and 11 ppm respectively.
- Experimental design was a RCBD with three replications.
- Treatments included foliar phosphate and traditional TSP fertilizer. Urea was applied to meet N deficiency. Also, a combination of foliar phosphate and soil applied P fertilizers were used.
- “Nutriphite Take Off”- a formulation of phosphate and organic acid was used as a source of phosphate which contains 3%N, 20%P₂O₅, and 7% K₂O. A 2% solution was used per spray.
- Pioneer corn hybrid “P0902XR” was used at the rate of 32000 plants/acre. In the greenhouse, two corn seeds were planted in each pot.
- Foliar applications were made at V6 and VT growth stages at a flow rate of 150 L ha⁻¹.
- Data were collected and analyzed in SAS using PROC GLM and PROC MIXED procedure.

**Results**

Table 1: Influence of foliar phosphate on yield, N and P conc. in grain, leaf, and stem. Lake Carl Blackwell in 2011.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Grain Yield [kg/ha]</th>
<th>Grain N Total %</th>
<th>Grain P Total %</th>
<th>Leaf N Total %</th>
<th>Leaf P Total %</th>
<th>Stem N Total %</th>
<th>Stem P Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>932.51</td>
<td>1.23</td>
<td>0.39</td>
<td>1.22</td>
<td>0.23</td>
<td>0.30</td>
<td>0.23</td>
</tr>
<tr>
<td>N</td>
<td>2465.15</td>
<td>1.39</td>
<td>0.37</td>
<td>1.52</td>
<td>0.22</td>
<td>0.40</td>
<td>0.19</td>
</tr>
<tr>
<td>V6</td>
<td>269.95</td>
<td>1.44</td>
<td>0.4</td>
<td>1.04</td>
<td>0.25</td>
<td>0.38</td>
<td>0.27</td>
</tr>
<tr>
<td>V6+VT</td>
<td>814.28</td>
<td>1.38</td>
<td>0.38</td>
<td>1.09</td>
<td>0.25</td>
<td>0.38</td>
<td>0.29</td>
</tr>
<tr>
<td>N+V6</td>
<td>1772.92</td>
<td>1.39</td>
<td>0.42</td>
<td>1.47</td>
<td>0.25</td>
<td>0.38</td>
<td>0.26</td>
</tr>
<tr>
<td>N+V6+VT</td>
<td>1808.43</td>
<td>1.43</td>
<td>0.45</td>
<td>1.86</td>
<td>0.27</td>
<td>0.49</td>
<td>0.19</td>
</tr>
<tr>
<td>N+P</td>
<td>2680.26</td>
<td>1.37</td>
<td>0.41</td>
<td>1.53</td>
<td>0.25</td>
<td>0.38</td>
<td>0.22</td>
</tr>
</tbody>
</table>

**Contrasts**

- N+V6 vs. Control **NS**
- N+V6+VT vs. Control **NS**
- V6 vs. N **NS**
- V6+VT vs. N **NS**
- N+V6 vs. N **NS**
- N+V6+VT vs. N **NS**
- N+P vs. N **NS**
- N+V6+VT vs. N+P **NS**
- N+V6 vs. V6+VT **NS**
- N+P vs. V6+VT **NS**

Note: NS, *, and ** denote non-significant or significant at P ≤ 0.05 or P ≤ 0.01 respectively. N = soil applied full N fertilizer as urea. P = soil applied full P fertilizer as TSP. V6 = foliar phosphate spray at V6 growth stage, and VT = foliar phosphate spray at VT growth stage.

**Conclusion**

Treatment effects were minimal due to severe heat and drought in 2011. In the field study; grain yield, N and, P concentration significantly increased when foliar phosphate was sprayed with nitrogen fertilizer. Grain yield, grain P concentration, leaf total nitrogen, and stem P concentration were significantly higher when phosphate was applied at V6 and VT growth stages compared to single application at V6 stage. Traditional soil applied TSP and urea resulted in the highest yield. This is because, the amount of foliar applied P was below total plant need. This study suggest that, in low P soils, foliar P alone is not sufficient.

**Acknowledgement**

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- Other committee members for their kind advising.
- Graduate students who helped me during data collection and processing samples.
- The study was partially supported by Biagro Western LLC.

**References**


**Figure 1:** A leaf in the greenhouse trial that shows P deficiency.

**Figure 2:** Corn grain yield [kg/ha] as a function of NDVI. Lake Carl Blackwell in 2011.

**Figure 3:** A section of a corn leaf that shows damage caused by foliar spray.