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Phosphites as Fertilizer

Recently, farmers in southeastern Alabama, southern Georgia and northern Florida have experienced problems that seem to be related to a non-conventional fertilizer material used as a starter fertilizer. The material, ammonium phosphite, was used in a manner similar to ammonium polyphosphates that is commonly sold as 10-34-0 liquid fertilizer. There is a difference.

Orthophosphates

Most fertilizer phosphorus (P) is in the form of orthophosphates or simply phosphates as they are sometimes called. This is the form taken up most readily by plant roots.

$HPO_4^{=}$ . . . divalent phosphate anion taken up by plants
$H_2PO_4^{-}$ . . . monovalent phosphate anion taken up by plants
H_3PO_4 . . . ortho phosphoric acid

$(NH_4)_2HPO_4$ . . . diammonim phosphate (18-46-0), a component of most dry fertilizers

$(NH_4)_3H(PO_4)_2$ . . . triammonium pyrophosphate (a component of ammonium polyphosphate liquid fertilizer sold most often as 10-34-0)

$CaHPO_4 + Ca(H_2PO_4)_2$ . . . calcium phosphates, a primary component of triple superphosphate or concentrated superphosphate (0-45-0)

Analytical techniques used in soil testing and in fertilizer regulatory laboratory are specifically selected to measure P as orthophosphate because this is the form which plants use.

Phosphites

Phosphorus can be present in other chemical forms although these are rarely encountered in the fertilizer and agricultural industry. Phosphites are made from phosphorous acid (H_3PO_3). Adding ammonia (NH_3) will make an ammonium phosphite salt. Phosphites (PO_3) are not as stable as phosphates (PO_4). In an oxidizing environment such as that found in an agricultural soil, phosphites will convert to phosphates. The effects of phosphite as a fertilizer was first described in 1953 (Adams, 1953). The oxidation process can be broken into three categories: chemical, enzymatic, and biologic. Early research showed that microbial activity oxidized phosphite the quickest. After 16 weeks, 99.9% of the original phosphite was converted to phosphate in an agricultural soil. Phosphite was also found to be toxic to plants at high rates. More recent research revisted the problem of phosphites as a fertilizer. Root and shoot growth were decreased when phosphite rate was 24 kg ha^{-1} (Barrett, 2002). McDonald et al., 2001 found

that phosphite is not utilized, but may trick P deficient plants into not mimicking typical P deficienies. Wells et al. (2000) found that toxicity symptoms in alfalfa disappeared after 21 days.

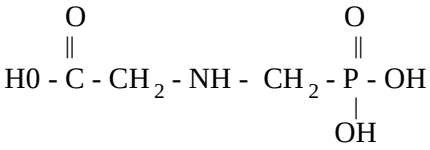
In 1975, problems were encounted on over 1500 acres of corn in southern Michigan that was traced back to a 9-18-9 liquid fertilizer containing phosphite. The fertilizer was either foliar applied or applied in a band in contact with the seed. About 5 gallons per acre was used. "Plants showed white, variegated streaking of the leaves in mild cases and spindly, rolled, yellowish-white leaves in severe toxicity" (Lucas, et al., 1979). Interesting, no such symptoms were observed in 1976 when the same material was used.

Ammonium phosphite (11-35-0) was compared with ammonium polyphosphate (10-34-0) as a starter fertilizer on cotton on irrigated and non-irrigated sites in South Georgia in 2003 by Harris (Dr. Glen Harris, UGA-Tifton, unpublished data from personal communications.). Both materials were applied at 12 gallons per acre in a 2x2 band at planting and applied on the surface. The ammonium phosphite resulted in shorter plants at the fourth true leaf stage but no differences in leaf P concentration and no significant differences in yield at harvest were observed. Therefore, conclusions from this one-year test were ". . .inconclusive and the effectiveness of 11-35-0 (ammonium phosphite) as a starter fertilizer for cotton needs further study."

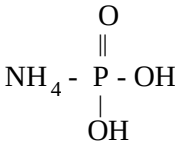
Phosphite injury to corn in Southeast Alabama, 2004. Photo courtesy of Rob Duffield.

An Interesting Observation

The symptoms described by Lucas et al. (1979) for phosphite injury to corn in Michigan and symptoms observed this year in Alabama and Georgia (see photos) closely mimic glyphosate



Glyphosate



Ammonium phosphite

damage, a amino acid inhibitor. A phosphite group is an important component of this widely used herbicide. Phosphite, like glyphosate, seems to be more toxic to grasses than certain broadleaf crops.

Testing for Phosphite

Phosphite may go undetected by most agricultural testing laboratories that are set up to test for orthophosphate. Approved techniques for fertilizer testing only measures orthophosphates. However, some non-regulatory laboratories are switching to inductively coupled argon plasma technology for rapid analysis of several elements simultaneously. This technology has the capability of measuring total P whether orthohosphate, phosphite, or solubilized organic P. If this technique were used to measure total P, it could create the impression that plant-available P is higher than it really is if some of this P was phosphite. Testing for the phosphite anion alone is tedious and expensive.

Phosphite stunted corn (L) compared to normal corn in Southeast Alabama, 2004. Photo by Rob Duffield.

Summary

Phosphites should not be used as a substitute for plant-available, orthophosphate forms of phosphorus. Phosphite is not immediately plant available and could lead to toxicities in sensitive crops if high rates are applied. Phosphite damage appears amazingly similar to glysphosate injury to crops. Phosphites will eventually convert to phosphates within a few days to a few weeks of application.

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