



Crop File

AVAIL® - phosphorus fertilizer additive

AVAIL® is a fertilizer additive or “enhancer” for use with phosphate fertilizer materials. It is not a fertilizer or fertilizer substitute and by itself has no nutrient value. AVAIL is a polymer material applied with phosphate fertilizer. Nutrisphere® is a similar product used with nitrogen fertilizer.

There are several different formulations, but a common formulation is 40% to 60% maleic itaconic copolymer solution. Specific formulations can be either impregnated with or applied to dry prilled fertilizer or may be mixed with liquid phosphate fertilizers.

Manufacturer literature notes that AVAIL “sequesters antagonistic ions such as iron, aluminum, calcium and magnesium that tie up phosphate in the soil surrounding the fertilizer”, “reduces tie-up of phosphate”, and “makes phosphate more available to the plant”.

The AVAIL mechanism of action is due to the large net negative charge of the maleic itaconic copolymer. This provides the material with a high cation exchange capacity (CEC), about 1800 milliequivalents/100 gram (meq/100g). By comparison, sand-size particles have CEC values of about 1 to 2 meq/100g and soil organic matter has a CEC of 200 to 400 meq/100g.

AVAIL can interact with positively charged ions in soil solution (Ca^{++} , Mg^{++} , Al^{+++} , Fe^{++} , etc.) that typically react with the phosphate ions (HPO_4^- , H_2PO_4^-) in solution, eventually forming less soluble phosphate minerals. The high CEC can remove (or “sequester”) these antagonistic cations, preventing them from interacting with phosphate ions. Theoretically, applying of this material with a phosphorus fertilizer source should improve phosphorus availability - least in the short term.

The CEC of the AVAIL copolymer is not affected by pH. It tends to affect multivalent cations (more than one positive charge), having a higher attraction for cations with a higher valence. Thus, some of the micronutrient metals, like zinc or nickel, may be highly attracted to the copolymer.

Theoretical effect

The potential effect of the copolymer on the soil CEC can be calculated from the existing soil CEC (from a standard soil test report), the product CEC, and the product rate using a weighted average approach. The actual rate of copolymer applied to the soil can be calculated from the fertilizer rate, the recommended product rate per unit fertilizer, and the product.

For example, one AVAIL formulation weighs 10.8 lb per gallon, has 40% copolymer, and is mixed with dry phosphate at one-half gallon per ton. A 100 lb/ac application of dry phosphate fertilizer would contain 0.27 lb of material or 0.108 lb of copolymer. Assume the fertilizer is mixed 6 inches deep into a very sandy soil with a CEC of only 5 meq/100g. The copolymer would be diluted with approximately 2 million pounds of soil, resulting in a minuscule increase from a CEC of 5.0000 meq/100g to a CEC of 5.0001 meq/100g.

- $2,000,000 \text{ lb soil} * 5 \text{ meq/100g} = 10,000,000 \text{ meq of charge}$
- $0.108 \text{ lb copolymer} * 1800 \text{ meq/100g} = 194 \text{ meq of charge}$
- $10,000,194 \text{ meq of charge} / 2,000,000.108 \text{ lb of soil plus copolymer} = 5.0001 \text{ meq/100g final CEC}$

The copolymer product can also be mixed with liquid fertilizer and band-applied. Band application only mixes the product with a small fraction of the total soil volume. Applying a 1-inch diameter fertilizer band on 30 inch spacing mixes the copolymer with only 0.4% of the soil volume in the top 6-inch of soil or 8000 pounds. A 40% copolymer product with a density of 9.7 lb/gal is recommended at 0.5 gallons per 99.5 gallons of phosphate fertilizer. Assuming a liquid fertilizer density of 11.6 lb/gal, each 10 gallons of applied fertilizer would include 0.194 lb of copolymer. Using the weighted average approach, the CEC in the 1-inch diameter band would change from 5.00 meq/100g to 5.04 meq/100g.

- $8,000 \text{ lb soil} * 5 \text{ meq/100g} = 40,000 \text{ meq of charge}$
- $0.194 \text{ lb copolymer} * 1800 \text{ meq/100g} = 349 \text{ meq of charge}$

- 40,349 meq of charge / 8000.194 lb of soil plus copolymer = 5.04 meq/100g final CEC

Based on these calculations, this small change in CEC would be expected to have little impact on phosphate availability. These calculations were also based on a sandy soil (CEC = 5). The change in CEC would be proportionately less with finer textured soils having higher clay content.

Field research results

Following are a collection of research trials using AVAIL with various phosphate fertilizers on corn, soybeans, and fescue. This is not intended to be a comprehensive listing, but rather a listing of readily available research results with summary information and reference source. Research information suggests that AVAIL can increase yields, but not consistently and not predictably. Producers should carry out small scale, side-by-side comparisons to evaluate the suitability of any additive in their operation.

Ohio State University, 2008: "The AVAIL SD phosphorus fertilizer enhancer was blended in with the 2-20-18 liquid fertilizer at a rate of 0.5% prior to application in the seed furrow. ... The results from this one year study did not show any statistically significant differences in harvest population, moisture, or (*corn*) yield for any of the starter fertilizer applications over the untreated check plot." http://farmfocus.osu.edu/corn_starter_fertilizer-08.pdf

Ohio State University, 2008: "The greatest concern regarding AVAIL is that information limited at present, so widespread use of this product may not be warranted. The other issue to be considered is how high soil P fertility affects response. High P soils are unlikely to benefit from application of this material, but research information is not available at this time." (in C.O.R.N Newsletter, April 2008) <http://corn.osu.edu/index.php?setissueID=224>

North Carolina State University, 2007: "Results from all eight of these tests showed that at recommended starter fertilizer rates, there was no (*corn*) yield advantage with AVAIL. In ... soils testing medium to very high for phosphorus, nitrogen-only starter fertilizer did statistically as well as nitrogen+phosphorus starter or nitrogen+phosphorus+AVAIL starter." <http://stanly.ces.ncsu.edu/files/library/84/Fertilizer%20Additives.3.7.2008.pdf>

University of Delaware, 2007: "These studies showed no (*corn*) yield benefit from using starter fertilizer with or without AVAIL added to the fertilizer. Starter fertilizer did result in significant early growth responses, but adding AVAIL did not result in increased early growth." http://ag.udel.edu/plsc/faculty/documents/Cooperative_Bulletin_118_Binford_AVAIL_2007.pdf

North Dakota State University, P. Hendrickson, 2007: "Using ... or AVAIL provided (*corn*) yields similar to the in-furrow application at the same fertilizer rate." <http://www.ag.ndsu.nodak.edu/carringt/07data/07%20Annual%20Report/Corn%20Response%20to%20Fertilizer%20Placement%20and%20Starter%20Fertilizer%20Rates.pdf>

Tindall, T.A. 2007: "Recent Advances in P Fertilizer Technologies – Polymer coatings and AVAIL Technology". Proceedings of the Western Nutrient Management Conference, Salt Lake City, Utah. Vol. 7, pg. 106-110. http://cropandsoil.oregonstate.edu/sites/default/files/WERA103/2007_Proceedings/WNMC07.p106.Tindall.pdf

University of Kentucky, L. Murdock and J. James, 2007: "After two years of testing, it appears that the AVAIL® polymer on MAP or DAP will not increase the availability of the phosphorus in these phosphate fertilizers to fescue as evaluated under the conditions described in this report." (in *UK Forage News*, Feb. 2008) <http://www.uky.edu/Ag/Forage/February%202008.pdf>

Kansas State University, W.B. Gordon, 2001-2004: "When averaged over years and P rates ... the AVAIL-treated MAP increased corn grain yield by 18 bu/a over the untreated MAP ... plots treated with MAP plus AVAIL increased soybean yield by 9 bu/a over the untreated-MAP plots the use of AVAIL with P fertilizer increased

plant P uptake and yield of corn and soybeans ." <http://www.oznet.ksu.edu/library/crpsl2/srp957.pdf>

University of Minnesota, G. Randall and J. Vetsch, 2002-2004: "In the two (of 3) "responding" years, broadcast-applied AVAIL (coated DAP) was superior to conventional DAP in one year, but there was no difference between AVAIL (coated MAP) and conventional MAP in the other year. ... Based on these data, the AVAIL products (coated ammoniated phosphates) appear to possess characteristics that allow greater P availability in calcareous soils and give higher corn yields in some cases. However, the inconsistency as noted by a 20 bu/A yield advantage for broadcast AVAIL (coated DAP) over conventional DAP in one year and no yield difference between AVAIL (coated MAP) and conventional MAP in another year is of concern. The poor performance of 2" x 2" starter-placed AVAIL with 7-21-7 is also of concern. Our three site-year findings suggest that more trials be conducted in a very organized fashion to determine when and why the AVAIL products will out-perform conventional DAP and MAP most consistently and significantly."
<http://sroc.cfans.umn.edu/research/soils/Recent%20Completed%20Project%20Summaries/Effect%20of%20Avail.pdf>