# Iowa State University Extension Phosphorus and Potassium Soil-Test Interpretation Guidelines Have Changed

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Guidelines for soil-test phosphorus (P) and potassium (K) interpretations and application rates were last updated in 2013. Since then, significant field research was conducted to assure that nutrient management guidelines are kept current. The new response data, increased crop yield levels in Iowa, and better awareness of usually large spatial soil-test variability in production fields indicated a need for adjusting the boundaries of soil-test interpretation categories and suggested nutrient application rates. The updated publication PM 1688 has been posted for free download at the Iowa State University Extension Publications Store and the Soil Fertility websites. This is a brief overview of major changes made and what remains unchanged based on the available research data.

**Main reasons for the changes**

Improved crop genotypes have been introduced to production agriculture and yields of mainly corn and soybean, but also other field crops, continue increasing. Since the prior update in 2013, about 200 field response trials for P and K with both corn and soybean crops were conducted at five ISU research and demonstration farms -- in central, northeast, north central, northwest, southeast, and southwest Iowa. These research farms have different soil types, and the weather (mainly rainfall and temperature) differs somewhat across farms. While new research was not conducted for other field crops, the guidelines were adjusted by using previous relative differences with corn and soybean and information from similar soils in neighboring states.

However, the fundamental concepts used for developing the new guidelines remained the same. The general objective is to accomplish long-term profitability and reduced risk of yield loss while maintaining or improving the sustainability of crop production and water quality. This is attained by emphasizing crop response-based fertilizer applications for the low-testing categories targeted to maximize yield in most conditions; recommending removal-based maintenance using prevailing crop yields (not necessarily yield goal) for a soil-test category with low probability of a small yield response (the optimum category), and for the high category recommending only common starter rates for some conditions described in the publication.

**What has changed?**

Two key areas have been updated. One important change was to adjust the boundaries for the soil testing categories -- mainly by moving the boundary for the optimum category up to make it wider. This is justified by the observed variation in the magnitudes of yield responses and further recognition of the intrinsic uncertainty of soil-test results mainly due to high spatial variability despite use of improved dense sampling methods. Also, despite significant improvements in laboratories quality control and many years of proficiency soil testing programs in Iowa, the bias in test results among laboratories continue being substantial since its complete elimination is very difficult.

The left graph in Fig. 1 shows the available relative grain yield responses of corn and soybean to P fertilization for a wide range of soil-test results using the Bray-1 or Mehlich-3 tests using the standard colorimetric measurement of extracted P (these tests continue to be statistically equivalent except in calcareous where the Bray-1 should not be used). For reference, the previous interpretations in the PM-1688 publication and the new categories are indicated in the figure. Even discounting a few outliers, the responses below the 95% relative yield for the low and optimum categories suggest a need for raising those boundaries by a few parts per million. These adjustments also maintain the traditional criterion for all categories -- to comprise probabilities of response around 80, 60, 25, and 5% for the very low, low, optimum, and high categories. This is shown by the right bar graph in Fig. 1.

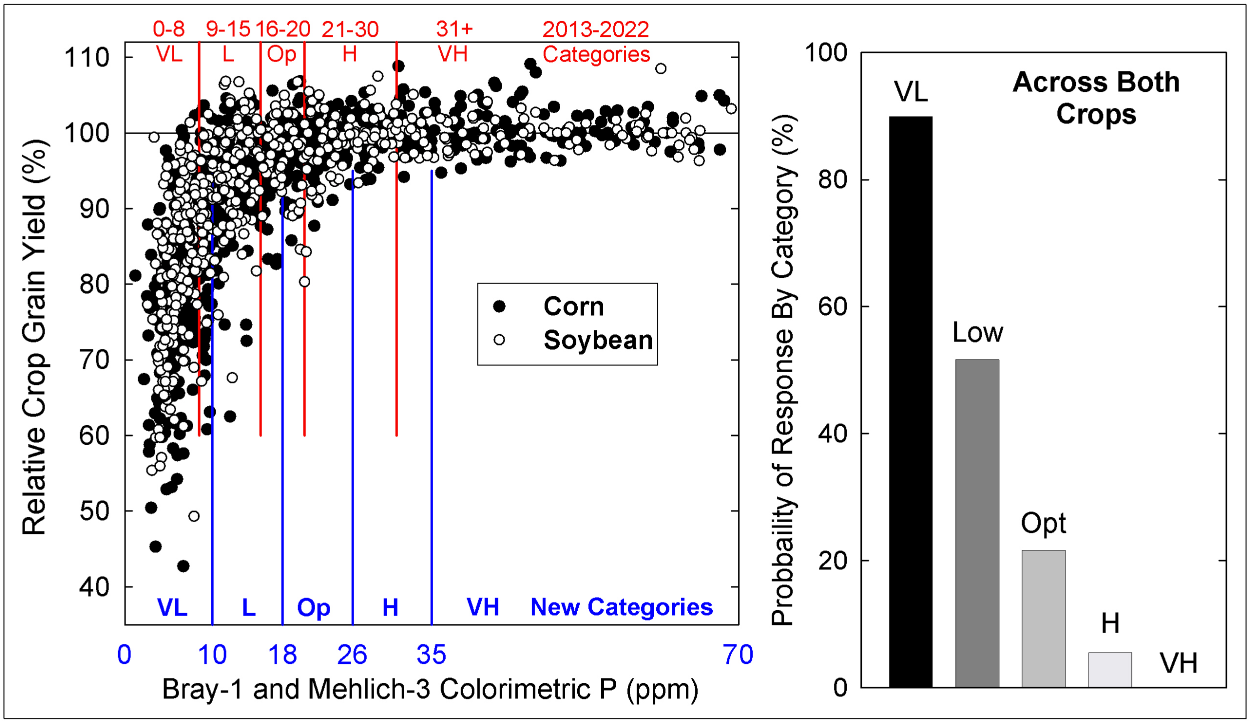


Fig. 1. Relationships between soil-test P and relative corn and soybean grain yield responses [the previous (top) and new (bottom) soil-test categories are shown] and probabilities of response within each new category (right). VL=very low, L=low, Opt=optimum, H=high, VH=very high.

Graphs in Fig. 2 show the new relationships for soil-test using the dry and moist (or slurry) sample handing procedures and the probabilities of response for each category for the ammonium-acetate and Mehlich-3 tests (which continue to be statistically equivalent). The graphs demonstrate the need for similar changes as mentioned for P. An important finding of the recent research is that it confirmed the moist K test is much more reliable than the dry test and its use results in more accurate and profitable K fertilization – especially in specific soils identified as problematic for the dry test. This is especially the case in productive soils that are classified with moderately poor to poor drainage, even if tile drainage is present. New study of soil properties showed that mainly poor soil drainage with alternating saturated and dry conditions over the seasons combined with slightly different clay mineralogy to other soils partially explain the bad performance of the dry K test on these soils – which are commonly found in central to northern Iowa but also in other areas.

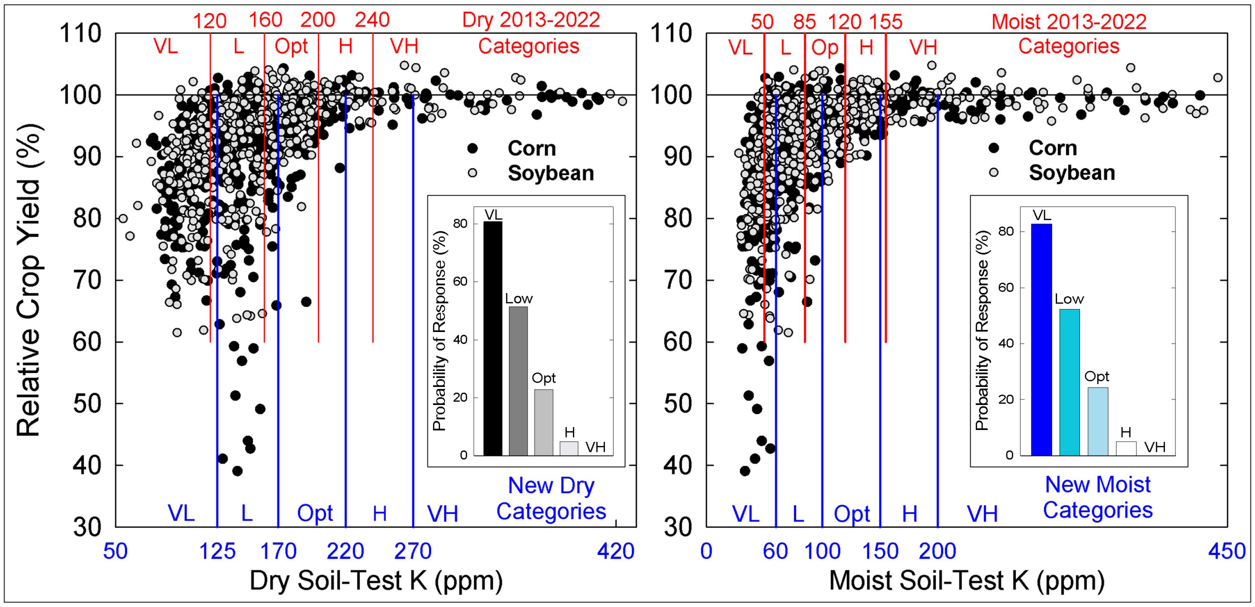


Fig. 2. Relationships between soil-test K using the dry and moist sample handling procedures and relative corn and soybean grain yield [the previous (top) and new (bottom) soil-test categories are shown) and probabilities of response within each new category for each sampling handling procedure (bar graphs). VL=very low, L=low, Opt=optimum, H=high, VH=very high.

The other significant change was to increase the suggested P and K fertilization rates for the very low and low interpretation categories. These changes cannot be detailed here and are easy to see in tables for several crops in the publication. The reason for the increase is to maintain the traditional concept in Iowa P and K recommendations of assuring that the rates attain maximum yield in most conditions while gradually increase postharvest soil-test levels. Default yield and removal-based application rates were also increased for the optimum category. These defaults are only general guidelines for instances when laboratories do not receive yield level information. As PM 1688 as stated for decades, producers should use prevailing yield levels and provided P and K concentrations to estimate removal-based rates for the optimum category.

**What was not changed?**

The recent research confirmed that the Bray-1 soil P test is unreliable in calcareous soils and either the Olsen or Mehlich-3 P tests should be used, different soil-test interpretations are needed for the Mehlich-3 test with colorimetric or ICP measurements of extracted P, soil K test results by the ammonium-acetate or Mehlich-3 K tests are more reliable when using the field-moist or slurry sample handling procedure than the dried sample procedure mainly in soils with moderately poor to very poor drainage, for all tillage systems equivalent crop responses typically occur for broadcast and planter-band P application (other than starter in some conditions), and broadcast or planter-band K applications continued showing no consistent differences. No new deep banding research was conducted but many previous field trials before 2013 had shown that deep band P is not better than broadcast P for corn or soybean with any tillage system and that deep-band K is a must with ridge-tillage but may be beneficial only occasionally for corn managed with no-tillage or strip-tillage mainly in dry years.