The Olsen soil P test - trends in time, certainty and sources of variation

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A modified version of the Olsen soil P test has been used by farmers in Denmark since 1987. Initially it was used to roughly judge the soil P status and facilitate recommendations on P fertilization. Today it is also used as an indicator for increased risk of P losses to surface waters, as it is now stated in Danish law-based regulations, that farmers, who wish to extend their number of livestock, have to live up to requirements regarding the soil P test values. This development necessitates high precision and reliability of the test results along with information on how fast Olsen P changes with time in response to different P fertilization. The objective of this study is therefore: (1) to estimate the uncertainty and sources of variation in the results obtained with the Danish modified Olsen soil P test, (2) to suggest how to improve certainty of this soil P test and (3) to evaluate the regional trends in Olsen P from 1987 to 2007. We analyzed three datasets:

Inter-laboratory comparisons: Estimates of uncertainty and sources of variations in modified Olsen P test were obtained from a statistical analysis of results of the mandatory, inter-laboratory comparison of performance of the modified Olsen P, which was carried out on seven authorized soil laboratories between 1997 and 2003. We found that the test result varied systematically between laboratories and between individual test series at the labs. Furthermore accuracy of the labs was highly variable exemplified by a 10 fold larger residual variance at the lab having the highest compared to the lab having the lowest residual variance.

Repeated analyses of two reference soils at two labs: A statistical analysis of results on two reference soils analyzed 205 times between 1999 and 2003 at the lab responsible for practical aspects of the soil laboratory authorization and a similar dataset on the same reference soils analyzed 77 times at our research lab between 2004 and 2008. The date of analysis, temperature and slope of the standard curve was included in this analysis. Test results varied much less between these two labs and with time of analysis than in the above described inter-laboratory comparison. On the other hand this analysis revealed that the test results declined significantly (0.8 mg P kg^{-1} y^{-1}) with time in the oldest dataset, but much less and insignificantly between 2004 and 2008, indicating that Olsen P value of stored reference soils may decline during the early years of storage. Increasing the temperature during extraction with 1°C resulted in increases of 0.7 mg P kg^{-1} in the early test period. In the second and newest dataset the protocol for the analysis only allowed modest temperature variations, which eliminated the effect of temperature. The residual variance of the test value of one of the soils could be minimized by using the test result of the other soil for correction. To overcome the difficulties of obtaining precise and accurate Olsen P values we therefore recommend strict control of extraction time and temperature and inclusion of well stored reference soils in each set of analyses to be used for final correction of the test result.

Farmers' routine soil analyses: Farmers' test results were collected between 1987 and 2007 for seven Danish regions. Regions known to have low animal densities also had lover test levels. From 1992 there was a significant decline in Olsen P in all regions, which corresponds to the positive yet declining yearly net national agricultural P surplus. In regions having low animal densities Olsen P declined faster than in regions having high animal densities.