A PRELIMINARY ASSESSMENT OF KCl-40 SULPHUR SOIL TEST - FOR CANOLA

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ABSTRACT

The effectiveness of two extractants to determine soil S levels were compared in eleven canola field experiments. Soil samples were analysed for S by two extraction techniques, mono-calcium phosphate and heated 0.25 M KCl extractable sulfur. Clean seed yield was correlated with S extracted by the two tests. The 0.25 M KCl extractant proved more effective at predicting S yield response.

INTRODUCTION

This assessment is part of a three year field study to evaluate the effectiveness of different tests in determining soil nitrogen and sulfur (S) status, to improve the accuracy of predicting Canola fertiliser requirements and yield responses. Results from one season are reported for two S extractants.

Researchers have used a large number of techniques to predict the occurrence of S response by plants. The techniques used can be categorised by the sulfur extracted, ie inorganic S, inorganic S plus various amounts of organic S and total S. Common extractants which have been used to extract sulfur from the soil are $CaCl_2$, NH_4Cl, $Ca(H_2PO_4)_2$, $NaHCO_3$ and KCl. Many more extractants have been trialed through the years, but the most common extract used has been mono calcium-phosphate (MCP) (Anderson *et al.*, 1992). In annual pastures, this extractant has been poorly correlated with yield since it underestimates the supplying power of the soil. The KCl-40 test was developed to increase the reliability of pasture S tests (Blair *et al.*, 1991). An objective of the project was to assess KCl-40 S soil tests suitability for Canola.

EXPERIMENTAL

Eleven N x S factorial canola field experiments were conducted during 1992. Nitrogen was applied at rates of 0, 20, 40, 80 and 160 kg N/ha and sulphate sulfur at 0, 10, 20 and 40 kg S/ha (Good *et al.*, 1995). Approximately four weeks prior to planting, soils were sampled to a depth of 90 cm by extraction taking four sections (0-15 cm, 15-30 cm, 30-60 cm and 60-90 cm) and analysing them for sulfur. Plots were harvested at maturity and the clean seed yield at 8.5% moisture determined.

Soil sulfur levels were determined by two methods.

1) The MCP method in which 20 ml of 0.01 M $Ca(H_2PO_4)_2$ was added to 4 g soil and shaken for 1 hour at 25 °C. The extract was analysed for SO_4^{2-} using ICP spectrometry.

2) The KCl-40 method where 20 ml of 0.25 M KCl was added to 3 g soil and heated for 3 hours at 40°C (Blair *et al.*, 1991). The extract was analysed for SO_4^{2-} using ICP spectrometry.

Percent maximum yield was calculated by the equation (+N-S) / (+N+S)*100. The +N value had N added at a rate of 160 kg / ha. The relationship between the amount of S extracted by the 2 extractants (kg/ha) for the four depths and yield was established by fitting a Mitscherlich relationship of the form,

$$Y = A*(1-b*(Exp(-c*x)))$$

where Y = % maximum yield, x = soil test (kg/ha), b = maximum response to an applied nutrient, and c = curvature coefficient. The relationship between S soil tests was calculated by fitting a linear relationship. The coefficient of determination (r^2) for the relationship between percent maximum yield and soil S extracted by MCP and KCl-40 is presented in Table 1.

Table 1: Equation for the Kcl-40 relationship between KCl-40 S and coefficient of determination between y = percent maximum yield and x = extractable S for the four soil depths.

Soil depth (cm)	Mitscherlich Equation for KCl-40 S	KCl-40 r^2	MCP r^2
0 - 15	y =100*(1-1187616*(Exp(-2.57*x)))	0.90**	0.09
0 - 30	y =100*(1-23178.7*(Exp(-1.055*x)))	0.92**	0.00
0 - 60 [A]		0.06 n.s.	0.00
0 - 90	y =100*(1-13.92*(Exp(-0.144*x)))	0.91**	0.08

*$p < 0.05$, **$p < 0.01$, [A] = a linear relationship.

The relationship was not significant for the MCP extractant at anys soil depth. The relationship for KCl-40 was significant at 3 soil depths. The highest r^2 value of 0.92 was at the 0-30 cm soil depth. The 0-60 cm depth could not be fitted with a Mitscherlich equation so a linear equation was fitted, resulting in a low r^2 (0.06). Figure 1 illustrates the high correlation for the KCl-40 S test at the 0-30 cm soil depth.

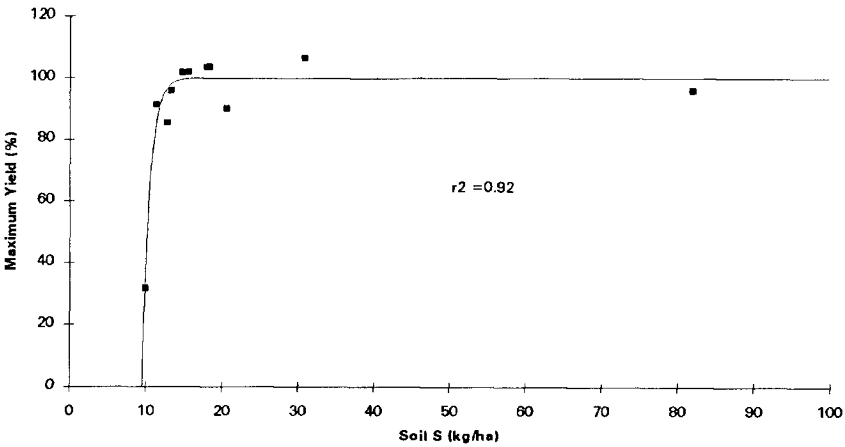

Figure 1: The fitted Mitscherlich curve for the relationship between KCl-40 extractable S and dry matter yield response for the 0-30 cm soil depth.

The linear relationships and the coefficients of determination for MCP and KCl-40 S are presented in Table 2. There were no significant relationships except for the 0-90 cm depth (r^2 = 0.81).This is unexplained.

Table 2: Coefficients of determination and linear equations for the relationships between MCP and KCl-40 sulfur for four soil depths.

Soil depth (cm)	Linear equation	r^2
0 - 15	y = 5.345 - 0.0276 x	0.04
0 - 30	y = 10.674 - 0.0736 x	0.11
0 - 60	y = 23.18 - 0.008 x	0.00
0 - 90	y = -38.29 + 1.043 x	0.81**

$^{**}p < 0.01$

DISCUSSION

The experimental data show a poor correlation between MCP extractable S and seed yield across 11 sites. The r^2 value of 0.09 for the 0-15 cm soil depth is substantially lower than the 0.45 found in pastures (Blair *et al.*, 1991). The data support the view that MCP performs poorly as a sulfur extractant since it cannot sample the organic S pool and hence results in the test under estimating the soil sulfate supplying power.

The coefficient of determination for the KCl-40 extractable S was 0.90 at the 0-15 cm soil depth. This value high for a field study, and is considerably higher than the $r^2 = 0.73$ for established pastures (Blair *et al.*,1991). It was surprising to find that having three soil depths with r^2 higher than 0.85, the 0-60 cm soil depth could not be fitted with a Mitscherlich curve. This occurrence can be explained by the fact that there were not enough data points in the intermediate sulfur range.

The high correlation for the KCl-40 S at the 0-90 cm soil depth indicates that this method predicts accurately available S at depth, thus confirming the view held by Blair *et al.*, (1991) that the KCl-40 extractant would perform well for deeper sampling. Sulfur at depth can be very important for canola since it has a deep root system. In 1993 and 1994 field experiments (data not shown) S responses have been recorded at a number of sites with high subsoil S levels. Investigations have revealed soil physical or chemical barriers can stop plant roots from accessing the subsoil S. The barriers included cultivation hard pans and subsoil acid throttles.

The KCl-40 test for predicting the S yield response in canola and pastures is now being commercially marketed following work that indicates the MCP method appears ineffective.Correlation research is in progress to relate KCl-40 extractable NO_3- to crop response and the data looks promising.

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