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Sulphur deficiency in canola

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Summary

Sulphur (chemical symbol S) deficiency, which reduces growth and protein levels in canola, is mainly seen in higher rainfall areas and where high analysis fertilisers, low in sulphur, are used. Symptoms on leaves are described, as well as the use of tissue tests and treatment by the use of fertilisers containing sulphur.

Sulphur is a plant nutrient essential for the formation of proteins where it is a constituent of amino acids such as cystine and methionine. Sulphur deficiency in plants results in reduced growth and protein levels.

Occurrence of sulphur deficiency

Plants can use S only in the sulphate (SO_4^{--}) form. Most of the S in the soil is contained in organic matter as proteins, amino acids and other compounds not immediately available to plants. Canola requires more sulphur than wheat or lupins because of its higher sulphur content. A 2 t/ha crop of canola will remove about 5 to 10 kg of sulphur, compared to about 4 kg for an equal weight of wheat and 5 to 8kg for lupins.

Sulphur deficiency commonly occurs in high rainfall pastures on sandy soils. Soils used to grow crops in Western Australia include deep sandy soils, sandy duplex soils comprising sand over loam, clay, or gravel, and soils where loam and clay occur at the surface. The loam and clay soils at the surface or in the subsoil have reasonable capacities to retain sulphate sulphur and typically contain more than adequate sulphur for canola production. The deep sandy soils include uniform deep yellow sandplain soils, and near the coast, such as the Eradu sandplain soils east of Geraldton; they typically contain about 2% clay, compared with 4-6% clay near Wongan Hills and Merredin, and 12% clay in the eastern cropping areas such as near Pindar, Tardun, Maya, Carrabin and Bodallin. The clay in the sandplain soils retain sulphate sulphur in all horizons of the soil so these soils usually have adequate sulphate sulphur for cereal and canola production. Deep sandy white and grey soils have low capacities to retain sulphate sulphur so that, depending on rainfall, leaching of sulphate sulphur beyond crop roots by rain can occur in these soils resulting in the crops becoming sulphur deficient for grain production. However, in these soils the amount of iron and aluminium oxides, usually as lateritic ironstone gravel, increases in the subsoil increasing the capacity of the subsoil to retain sulphate sulphur. Canola and cereal crops often show sulphur deficiency early during growth on these soils but the deficiency soon disappears as roots grow deeper and access more sulphate sulphur in the subsoil so grain yield increases (responses) to applied fertiliser sulphur rarely occur on these soils. However, increasing use of fertilisers containing negligible sulphur, and removal of sulphur from soil in grain, are likely to induce sulphur deficiency in the deep sandy white and grey soils. Deficiency for canola production may become a problem for these soils, particularly in wet years in higher rainfall areas due to greater leaching of sulphate sulphur below the rooting depth of crops in soil by rain. Application of sulphur fertiliser is required to prevent sulphur deficiency reducing canola seed yields.

Sulphate sulphur is easily leached in sandy soils. This often results in sulphur deficiency occurring in spring in high rainfall pastures, even though it is added in superphosphate in autumn. It is less likely to occur in traditional cropping areas where the rainfall is lower and consequently leaching of sulphate is reduced, especially in better loamy cropping soils. In addition, if the soil is cultivated, this increases break down of soil organic matter by soil organisms which releases sulphur in the organic matter as sulphate sulphur to the soil.

In the past, the widespread use of superphosphate as a fertiliser to supply the phosphate needs of a crop also helped prevent the occurrence of sulphur deficiency. Single superphosphate contains about 11 percent sulphur. Therefore, sulphur deficiency was rarely found in Western Australia.

However, in recent times there has been a trend towards more intensive cropping, often using high analysis fertilisers with low sulphur content such as diammonium phosphate (DAP - 1 per cent sulphur) and triple superphosphate (1.5 percent sulphur) so use of these fertilisers results in less sulphur being applied in these fertilisers to soil than single superphosphate. Ammonium phosphate fertilisers made in Western Australia are manufactured by adding ammonium sulphate to phosphoric acid to ensure the fertiliser contains sulphur, in order to maintain the sulphur status of the soils when single superphosphate is no longer used.

Symptoms of sulphur deficiency in canola

Sulphur is a component in some amino acids used to make proteins so deficiency affects the ability of plants to make some proteins. Sulphur is also necessary for the formation of chlorophyll, which is responsible for using solar energy to make sugars and carbohydrates in plants as sources of energy for metabolic processes in the plant. Sulphur is also essential for nitrogen fixation by legumes, a process which enables legumes, in association with rhizobia bacteria, to use atmospheric nitrogen to make the nitrogen compounds, including amino acids and proteins, plants require.

Symptoms of sulphur deficiency in old rapeseed varieties grown in a glasshouse are: paleness of the upper leaf surface, a rolling inwards of the leaves and the development of a deep pink colour on the undersides of the leaves. However, sulphur deficiency on newer canola varieties in the field causes different symptoms. There is still an inward rolling of the leaves and some development of the pink to purple colouration on the underside of the leaves. The most marked symptom in these field grown plants is a severe mottling or chlorosis between the veins on the leaves. The symptoms vary with the degree of deficiency. High nitrogen availability exacerbates deficiency.

Sulphur deficiency symptoms of canola

Soil and plant tests

Soil testing for sulphur uses hot (40°C) potassium chloride extractant (KCl-40). KCl-40 values less than 7 mg S/kg soil in the top 10 cm of soil indicate likely sulphur deficiency for canola grain production. Soil test S frequently increases down the soil profile, often making soil testing the top 10 cm of the soil misleading. Soils with soil test S values greater than 7 mg S/ka soil rarely respond to S fertilisers.

Concentration of S (%) and the nitrogen to sulphur ratio (N:S ratio) in whole shoots of plants declines as plants mature. At the rosette stage, the critical concentration was 0.6 % S and declined to 0.4 % at the flower buds visible stage. The N:S ratio at the rosette stage was 9.5, and declined to 8.0 at the flower buds visible stage.

Frequently plants are S deficient at early growth stages during cold wet months, but as roots explore a greater depth of soil, canola plants often recover with no seed (grain) yield response to added S fertilisers. This is even so when plant tissue levels are low to deficient. Knowledge of the distribution of soil test S down the soil profile will help overcome these diagnosis problems.

Treatment

Sulphur deficiency is avoided by applying sulphur containing fertilisers while sowing crops or the fertiliser is spread over the soil and crop when deficiency is identified after sowing. Deficient crops respond rapidly to applications of fertilisers containing sulphate sulphur. Table 1 lists the chemical analysis of some common fertilisers. Although data are limited, 12 to 20 kg sulphur/ha should be enough to prevent sulphur deficiency of canola even in poorer soils. On better light soils and medium textured soils, 8 to 12 kg sulphur/ha should be sufficient. However, knowledge of the distribution of soil test S down the soil profile will help improve the need for S fertilisers, based on the soil test values.

Sulphur, phosphorus and nitrogen content of some common fertilisers*

Fertiliser	% Sulphur	% Phosphorus	% Nitrogen
Sulphur**	99	0	0
Ammonium sulphate	24	0	21
Gypsum	16 to 18	0	0
Agras No. 1	14	9.1	16.1
Superphosphate	10.5	9.1	0
Double superphosphate	3.5-4.5	17.5	0
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.0Triple superphosphate	Up to 1.5	20	0
D.A.P.	about 1.0	20.0	18
AllStar	15.0	14.8	13.1
MaxAM fertiliser range	10.8 - 19.5	17.3 - 7.4	12.4 - 17.1
Cereal	10.6	17.7	12.3
Nutri-gras	15.2	8.1	16.5
Canola Rich	9.8	12.6	9.7
Agstar	9.4	14.0	14.3
agrich	10.4	12.0	9.7
Agflow	5.9	17.7	12.9
MacroPro Extra	9.8	11.2	9.7
Urea	0	0	46

** Some products have additional nutrients (eg trace elements) not listed here. It is advised that product range and current percentage of nutrient elements in fertilisers be checked with fertiliser companies, agents or rural traders, as products and percentage nutrient elements in products may change.*

*** Elemental sulphur, which is a sparingly soluble form of sulphur and so not readily available to plants until after application to soil. Elemental sulphur is converted by soil organisms to sulphate sulphur which can then be taken up from moist soil by crop roots.*

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