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Symptoms of Nutrient Deficiencies in Rape

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Photography by J. Feeney

Rape is a relatively new crop in Western Australia and this investigation was undertaken to produce visual symptoms of nutrient deficiencies so that they could be recorded and used for diagnosing deficiencies in the field. The appearance of mineral deficiency symptoms can vary considerably with growing conditions, so that symptoms produced in a glasshouse are only a guide to the probable symptoms in the field.

Two varieties of rape Arlo (*Brassica campestris*) and Target (*B. napus*) were grown in one gallon plastic buckets filled with acid washed silica sand. Three plants of each were grown in each pot and the treatments were duplicated.

A nutrient solution containing all the elements required for plant growth was applied to some as a control treatment. The other treatments were made up by deleting one element at a time from the complete nutrient solution. The nutrient solutions in the pots were replaced daily by applying 1 litre (1 $\frac{3}{4}$ pint) of fresh solution to the surface of the pots. All pots were flushed out with demineralised water weekly. Where deficiencies of the major nutrients (nitrogen, phosphorus, potassium, calcium, magnesium and sulphur) were being investigated it was found necessary to supply these nutrients at the beginning of the experiment to prevent the death of young plants. Each major element was later withheld and the deficiency symptoms recorded.

Rape seedlings consist of two small heart-shaped leaves (coty-

ledons) produced from the seed and an increasing number of oblong "true" leaves. The treatments used were designed to produce deficiencies as quickly as possible and most of the symptoms described and recorded in the photographs appeared on the first four to six mature leaves.

Deficiency symptoms

Nitrogen

At the two, true leaf stage the leaves were very pale green, with pink coloured midribs and petioles. The stems were pink and the cotyledons a red colour. At a later stage stems were a purple-red colour on Arlo (Fig. 1) and a duller red on Target. The older leaves showed colouring from yellow to red-orange with red veins. These lower leaves eventually died and the colouring extended through the next oldest leaves. Generally the older leaves showed much reduced leaf area compared with healthy plants and there was very little branching in these nitrogen deficient plants (Fig. 2).

Phosphorus

In the early stages the phosphorus deficient plants of both varieties showed reduced growth and dark green foliage. Arlo then developed a purple colour in the stems and leaf petioles (Fig. 3) similar to, but much darker than, that on the nitrogen deficient Arlo (Fig. 1). The older leaves of the phosphorus deficient Arlo plants showed purpling at the tips. These leaves soon turned to a dull purple-green colour (Fig. 4) and this condition gradually progressed to younger leaves. Target showed different symptoms; a very distinct pink-purple colour developed on the tips and margins of the oldest leaves (Fig. 5), which gradually spread further into the leaf blade and later developed orange and red hues. These symptoms were very similar to those on nitrogen deficient plants at the same stage. The only difference was that the nitrogen deficient plants had paler green younger leaves than the phosphorus deficient plants. In the field, it may sometimes be difficult to distinguish between these deficiencies at this growth stage of Target.

1. Nitrogen deficiency (var. Arlo) showing paleness of leaves, purpling of stems and colouring of older leaves.



2. Nitrogen deficiency (var. Target). The plant on the right is a normal healthy plant. The plant on the left is nitrogen deficient, showing reduced growth, pale upper leaves and yellowing of older leaves.



3. Phosphorus deficiency (var. Arlo) showing purpling of stems and petioles and dark green leaves.

5. Phosphorus deficient Target leaf showing purpling of margins.

4. Phosphorus deficient Arlo leaf showing dull purple colour.



6. Potassium deficiency (var. Arlo) showing collapsed surface cells of leaves (left) and necrotic areas formed (centre leaf).



7. Potassium deficiency (var. Arlo) showing yellowing of older leaf and necrotic areas.

9. Sulphur deficiency (var. Arlo) showing pale leaves with purpling around the edges.

8. Potassium deficiency (var. Target) showing puckering of leaves and development of yellow and brown colours from margins of the leaves.



10. Sulphur deficiency (var. Target) showing in-rolling of leaves and deep pink colour on the under-surface.



11. Magnesium deficient Arlo leaf showing inter-veinal chlorosis and also necrotic areas forming.

12. Upper surfaces of magnesium deficient Target leaves, showing the purple areas or spots.



13. Lower surface of magnesium deficient Target leaf, showing the deep pink colour of the interveinal areas.



15. Calcium deficiency (var. Arlo) showing the collapse of the flowering stalk and the crease formed in this collapsed section.



17. Severely calcium deficient Target plants showing the poor development of new leaves.



19. An early stage of manganese deficiency on an Arlo leaf, showing the development of interveinal chlorosis.



21. Boron deficiency (var. Arlo) showing the backward folding of young leaves with a shiny-oily appearance.



14. Calcium deficient Target leaf showing the yellow-brown colour of the interveinal areas and the green veins and green band at the periphery of the leaf.



16. Calcium deficiency (var. Target) showing the edges of a younger leaf rolling inward to give a cupping effect.



18. Zinc deficiency (var. Arlo) showing the "pepper-spot" symptom and necrotic patches forming around these spots.



20. A more advanced stage of manganese deficiency on an Arlo leaf, showing a marked interveinal chlorosis.



22. Boron deficiency (var. Arlo) showing the blackened dead growing point and the colouring round the margins of the leaves.



Potassium

Symptoms of this deficiency were a little different between the two varieties. The first symptom noticed on Arlo was the sudden collapse of the top layer of cells in the older leaves, so that the leaf showed what appeared to be waterlogged areas, which later became dead patches (Fig. 6). These leaves then became pale and turned yellow beginning at the margins initially and later extending in towards the midrib, so that the area around the midrib and veins remained green longest (Fig. 7). These older leaves began to die, followed progressively by the younger leaves. Flower heads then withered and died and eventually many of the plants died.

With Target there was no sudden collapse of cells. The first symptom was a puckering of the older leaves, which looked limp and had a dull sheen. A dull yellow or yellow-brown colour developed at the tips of these leaves and gradually spread towards the midrib, which remained green longest (Fig. 8). This condition then spread to the next oldest leaves. Generally Target did not appear to be as severely affected as Arlo.

Sulphur

Visual symptoms of sulphur deficiency were quite different for the two varieties of rape. At the 2 to 4 leaf stage Arlo showed a pink colour on the leaf midribs. This was browner than on the nitrogen deficient plants and there was no discolouring of the stems or cotyledons as there was with nitrogen deficiency at this stage. As the plants developed, the older leaves became pale and showed purpling around the margins (Fig. 9). Some of these leaves showed a tendency to fold inwards. This purpling then spread slowly from the margins through the interveinal areas of the leaves. At this growth stage the younger leaves failed to form a very wide blade, resulting in a fairly normal petiole and midrib but a narrow leaf. The flowers did not have the normal deep yellow colour but were very pale. Finally there was a purpling of the stem, petioles and leaf midribs.

The first symptom on Target was a very marked inrolling of the

leaves. Following this a deep pink colour developed on the exposed undersides of the leaves (Fig. 10). The newer leaves were poorly developed and the older leaves eventually changed to an orange colour before dying.

Magnesium

Symptoms of this deficiency appeared rapidly and were fairly similar on both varieties. The first indication was a yellowing or marbling on the leaves between the veins. Spots in these pale areas died as did some leaf tips (Fig. 11). The oldest pair of leaves tended to stay much greener and it was the leaves above these that first showed the marbling. The youngest leaves were at first unaffected but gradually developed the symptoms as they grew. The veins and midribs remained very green. Most of the leaves tended to fold backward as they died. Purple spots appeared in the interveinal areas on the upper surface of the leaves (Fig. 12) and all the interveinal areas on the back of the leaves took on a deep pink colour (Fig. 13).

Calcium

Symptoms were fairly similar on both varieties. Most of the growing points of newly emerged plants on the minus calcium treatment died. Consequently more plants were germinated and allowed to grow larger before the calcium was withheld. The tips of young leaves began to collapse and wither. Later the older leaves of both varieties showed mottling and the edges folded backward. Yellow brown areas developed between the veins leaving the veins and a band around the margin of the leaves green (Fig. 14). The flowering stalk then collapsed and subsequently the flower head withered and died (Fig. 15). The older leaves which had turned yellow began to die and the younger leaves turned inward at the margins to give a cupping effect (Fig. 16). At this stage emerging flower heads were brown and dying and new leaves were poorly developed (Fig. 17).

Zinc

There was apparently some zinc contamination so that there was no

severe zinc deficiency. However, the leaves of Arlo showed a "pepper-spot" symptom (Fig. 18), which developed as numerous, very small, dark brown spots on the upper surface of the leaves and later joined up to form small dead areas. The internodes between leaf axils appeared to be shorter than in normal plants and the flowering stalk in Arlo also appeared to be shortened.

Manganese

The symptoms on both varieties were the same, although they developed later on Target. The whole plants gradually became paler. A faint yellowing appeared between the veins (Fig. 19). The yellowing was most prominent on the older leaves and developed gradually until the interveinal areas were very yellow, while the veins remained dark green (Fig. 20).

Boron

The symptoms of this deficiency were similar on both varieties. At the 2 to 4 leaf stage, growth was reduced and all leaves tended to fold backward. Later the cotyledons and older leaves became thick and leathery and took on a dull velvety appearance. Soon after, many young leaves took on a very shiny-oily appearance and the margins folded backward (Fig. 21). Leaves emerging later did not readily unfold and became black and flaccid around the margins, while the older leaves showed yellow-orange-red colours around the margins. Eventually the plants showed clusters of unformed or poorly formed leaves around the growing point which turned black and died, while the older leaves had the coloured margins (Fig. 22).

Copper, molybdenum and iron

Symptoms of copper, molybdenum and iron deficiencies could not be readily obtained, apparently due to contamination. When copper was left out of the solution one interesting symptom was produced in the Target variety. These plants had an odour, like rotting tissue, confined to the growing point. However, there was no sign of rotting tissue either outside or inside the stems, and there were no visual symptoms.