FINAL REPORT TO
COTTON RESEARCH AND DEVELOPMENT CORPORATION

Project Number: DAN 61C

Project Title: INVOLVEMENT OF PHYTOTOXINS, PROBABLY HERBICIDES, IN THE GALATHERA SYNDROME

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EXECUTIVE SUMMARY

The Project

The Galathera syndrome affects cotton growing in the Namoi Valley, north–western New South Wales. Its symptoms include stunting and foliar discolouration of young seedlings, from which the plants may recover: but too late to reach their genetic potential for lint yield.

An earlier bioassay showed the presence of phytotoxin(s) in a Galathera–prone soil from the property of Auscott Pty. Ltd., Narrabri, N.S.W. (plate 1). This project sought to test that result and to find chemical and physical differences between Galathera and nearby non–Galathera soils which might account for differences, if any, in their phytotoxic properties.

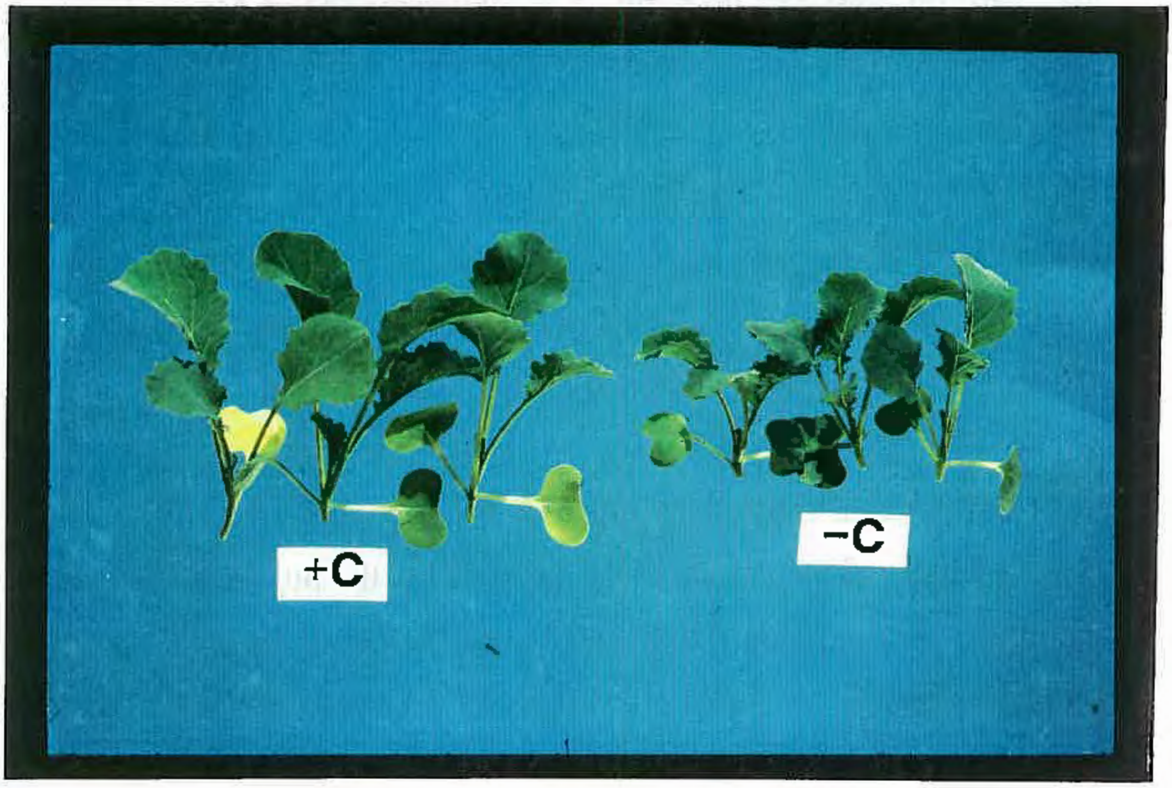

Plate 1. Tops of rape seedlings grown in Galathera soil. The plants on the left were grown in soil mixed with activated carbon.

The Studies

In the cotton fields in late 1991, 35 soil profiles were described and sampled for analysis on Auscott Pty. Ltd., Narrabri. Next, five pits were dug across adjoining cotton rows and wheel tracks – three in Galathera areas and two in non–Galathera areas. The soil in their walls was examined, rated structurally using *SOILpak* and tested for dispersion and shear strength. Undisturbed cores and clods, and disturbed soil close by, were sampled for analysis. Eight bulk soil samples were taken from near the pit sites for glasshouse experiments, i.e., from two Galathera fields (20 and 31) and two non–Galathera fields (11 and 18), at two depths on each site (0–10 and 10–20 cm).

In January 1992 cotton plants were measured and sampled for nutrient levels. For comparison, samples were taken from near the pit sites and elsewhere on Auscott's property. A second sampling in March 1992 measured lint yield and obtained root samples for study.

In the glasshouse the eight bulk samples were tested for the presence of phytotoxin(s) by growing cotton in them, with and without additions of a strong adsorbent (activated carbon). This trial also tested the effect of soil moisture status on the phytotoxic reaction.

A second pot trial studied the effect of water–logging on cotton, because observations on soil from the walls of the pits indicated that temporary poor aeration may contribute to the Galathera syndrome.

In the laboratory a program of measurement and analysis was undertaken – of soils, taken on survey and from the pits, of cotton plant tops taken in January 1992, of cotton roots and lint taken in March 1992 and of cotton plants and soils from the pot trials.

The Results

This report covers the pot work fully but, since the laboratory analysis and measurements on soils and cotton plant samples from the field are incomplete, only part of that work is presented.

In the field the appearance of soils from Galathera and non–Galathera areas was similar. Poor structure was more evident in the Galathera pits than in non–Galathera pits. The air–filled porosity of field moist cores from pit walls, taken in late November – early December 1991, was generally below the critical level and clearly lower in the Galathera pits. These observations suggested that poor aeration may contribute to the Galathera condition. A preliminary report was produced (Hawkins, 1992, see attached).

In the glasshouse the bioassay showed that phytotoxins were present in the surface 0–10 cm sample from field 20, the most Galathera–prone site, but not in the surface of field 31, the other Galathera site tested. No phytotoxin was detected in the subsurface (10–20 cm) at either of these sites. To our surprise both the surface and subsurface soils from the two non–Galathera sites (fields 11 and 18) contained traces of phytotoxin(s). These results, together with the fact that the fastest growth occurred on soil from field 20 in both the bioassay and the following experiment, lead us to conclude that phytotoxins are probably not the main cause of the Galathera syndrome.

We achieved poor aeration in the second glasshouse trial only after ponding water on the soil surface. These conditions depressed growth, caused foliar symptoms of nitrogen (N) deficiency, chlorotic and necrotic spotting on the younger leaves and reduced the concentration of phosphorus (P) and zinc (Zn). The soil from field 20, 10–20 cm, was the striking exception: growth increased; foliar levels of N, P and Zn were not depressed and no leaf symptoms developed.

The reduction in the foliar concentrations of a range of nutrients under water-logging in this trial resembles one aspect of the Galathera syndrome in the field; although, the leaf symptoms on the glasshouse plants (plates 2 and 3) were not the same as those found in the field. Seasonal variations in the occurrence of the syndrome also indicate that other factors, such as soil temperature, may be important.

The failure to achieve anoxia in the subsurface soil from field 20 and its slow onset in the subsoil from field 31, the other Galathera site, indicate low biological activity. This could result in different herbicide degradation rates and affect the production of microbial phytotoxins. In the field, reduced biological activity would slow down, but may not prevent, the development of anaerobic conditions.

Differences among the soils in pH, electrical conductivity, cations, lime content, organic carbon, C/N ratio, clay dispersion, clod shrinkage and particle size might account for the somewhat poorer structure, poor aeration and lowered biological activity in the Galathera areas and the generally sub-optimal air-filled porosity over all the pits, at high moisture content. But, not all these analyses are completed, so only tentative conclusions can be reached.

First, organic carbon has probably been halved in these soils since European settlement and C/N ratios are quite narrow. The Galathera areas appear to have higher carbon contents than the non-Galathera areas, but, despite this, their biological activity may be lower. Much depends upon the nature of the organic matter remaining.

Secondly, there appear to be differences in clay dispersion. In the laboratory, the two non–Galathera pits rated medium and two of the Galathera pits rated high, but the third Galathera pit (field 31) rated only medium. Dispersion measured in the field tends to be greater at all Galathera sites. Exchangeable sodium percentage, an important determinant of dispersion and other physical properties, does not seem to differ much between the two groups. However, lime, which counteracts the dispersive effect of sodium, is higher in the non–Galathera sites. Again site 31 is the exception.

Thirdly, soils from the Galathera sites had less favourable structure: when soil from the water–logging trial was dried, crushed using a known amount of work and put through a nest of sieves, the Galathera soils produced more coarse aggregates than the non–Galathera soils.

Thus, the Galathera condition, which is worse nearer the streams, is associated with poorer structure, lower air–filled porosity, greater dispersion and possibly lower lime in a set of soils containing 3 – 7% exchangeable sodium in the upper profile. The pattern of increasing lime as one moves laterally away from the stream is consistent with the lime in these soils having been transported by the streams, along with the sediments on which the soils were formed, in contrast with *in situ* formation of lime by weathering. This is analogous to the movement of more soluble salts in the prior stream landscape of the Riverine Plain of South–eastern Australia (Butler, 1950).