Anatomy of a problem weed: Polymeria take-all

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Polymeria take-all is a perennial weed infesting large areas of many western and northern cotton growing areas. A consultant survey conducted in 1996 ranked this weed as the fourth biggest problem, with even moderate densities of 100 stems per square metre reducing cotton yields by more than 50 per cent in patches where the weed occurs.

Polymeria take-all is difficult to manage, particularly with herbicides and shallow inter-row cultivation, because of its large below-ground rhizome mass. These rhizomes (underground stems) are responsible for the persistence and spread of Polymeria take-all.

Polymeria take-all is one of the cotton industry's biggest weed problems.

This article reports on anatomical studies on the stem and rhizome of Polymeria take-all. There are three reasons why it is important to understand the anatomy of this and other problem weeds.

Firstly, an understanding of anatomy may help improve our understanding of why some herbicides work better than others. Secondly, these studies help us understand why some weeds are so difficult to eradicate, and thirdly, they can shed light on the competitive relationship between weeds and cotton.

METHODS

The stem and rhizome material used was collected in late March 1999 from a cotton property near Moree. Rhizome material was taken to at least 15 cm in soil depth to ensure that the rhizome tissue sampled was as different as possible from the shoot tissue.

The material was prepared for observation by standard preparation techniques, in particular staining the sections so that cells could be easily differentiated. All material was examined under a compound microscope.

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TABLE 1: The various plant parts and their importance in the stem and rhizome sections of Polymeria take-all

Plant part	Stem (Fig. 1)	Rhizome (Fig. 2)	Importance
Epidermis	√	x	Outer layer of the stem, contains some chlorophyll for photosynthesis.
Periderm	x	√	A similar outer stem layer to the epidermis that helps prevent the rhizome from drying out.
Parenchyma	√	√	Storage cells that contain various plant products. There are a number of starch grains stored in the parenchyma cells in the rhizome.
Laticifers	√	√	Cells responsible for latex production (milky sap). Secretory cells surround the large latex canals.
Fibre bundles	√	√	Thick walled cells to give the stem support ('woody cells').
Outer and Inner phloem	√	√	Phloem carries plant sugars, water, nutrients, amino acids and hormones around the plant. They are similar to the vein in animals. Phloem is generally only found outside the xylem, but in some plants (sowthistle, thornapple, nightshade, paddy melon and many others), can also be found inside it.
Xylem	√	√	Xylem carries water and nutrients from the roots to the shoots. The cells generally have thickened cell walls. Inner xylem has not been shown.
Pith	√	√	Storage cells in the centre of the stem and rhizome. These are filled with starch grains in the rhizome section.
Starch grains	x	√	Starch grains can be found in parenchyma and pith cells particularly.
Crystals	x	√	Unidentified crystals (darkly or yellow stained) found in the parenchyma, phloem and pith tissues of the rhizome.

WHAT WE FOUND

Rhizome tissue similar to stem tissue — the case for auxin based herbicides

There are a number of tissues that compose the stem and rhizome tissues of any plant including Polymeria take-all. The study showed that most of these tissues were common in both stem and rhizome material (Figure 1 and 2, Table 1).

Knowing that the Polymeria take-all rhizome is similar to the stem suggests some important reasons why some herbicides are more effective than others.

Natural plant hormones known as auxins inhibit the formation of lateral buds on the stem — that is, they allow the growing point on the main stem to grow while growing points on the lateral stems are suppressed.

Theoretically, artificial auxin based herbicides such as the phenoxy group (2,4–D amine, 2,4–D ester, dicholorprop and MCPA) should inhibit both shoot initiation and disrupt cell growth in these rhizomes and so Polymeria take-all growth will be adversely affected.

In a number of trials, these herbicides have been shown to be more effective in controlling this weed than non-auxin based herbicides, with the exception of glyphosate (1998 *Australian Cottongrower* article on Polymeria take-all, volume 19, no. 5, pp 37–43).

This finding suggests that further field trials are needed to confirm the effects of auxin-based herbicides on Polymeria take-all in comparison with glyphosate.

FIGURE 1: Anatomy of the stem of Polymeria take-all

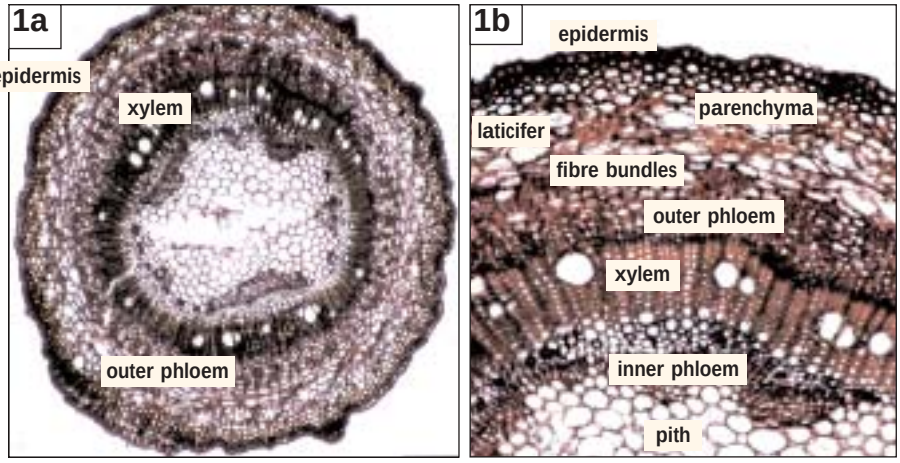

Figure 1a shows the entire section of the stem base (40X magnification), **Figure 1b** shows a section of tissue between the epidermis and the pith (100X).

The rhizome as a starch storage organ — why the weed is so difficult to kill

The rhizome functions as a storage organ for plant carbohydrates, and as a reproductive structure responsible for the production of new rhizomes, roots and aerial shoots. These plant carbohydrates — in this case starch grains — can be found throughout the rhizome sections (variously stained blue and green in Figure 2).

The starch grains are used as food for the plant to regrow, particularly after shoot death, due to cultivation, herbicide or frost damage. The large quantity of starch grains in the rhizome tissue illustrates why the weed is so difficult to kill by either shallow cultivation or single applications of herbicides, particularly in autumn when these sections were taken.

Whether starch accumulation varies with the time of the season and the growth stage of the plant is not known. If it did, the weed could be easier to manage when the starch reserves were depleted by active growth — for example, after reshooting in spring. Research is needed to investigate this.

Unidentified crystals — evidence for allelopathy?

There are a number of dark yellow and brown crystals found throughout the rhizome section (Figure 2c). These unidentified crystals are commonly found in other related species and are some form of manufactured or waste plant product.

Similar crystals have been used as drugs in the past (they may contain alkaloid compounds), and in other cases may be responsible for allelopathy. Allelopathy is the production of chemicals by one plant that inhibit the growth of surrounding plants.

When Polymeria take-all rhizomes are

FIGURE 2: Anatomy of the rhizome of Polymeria take-all

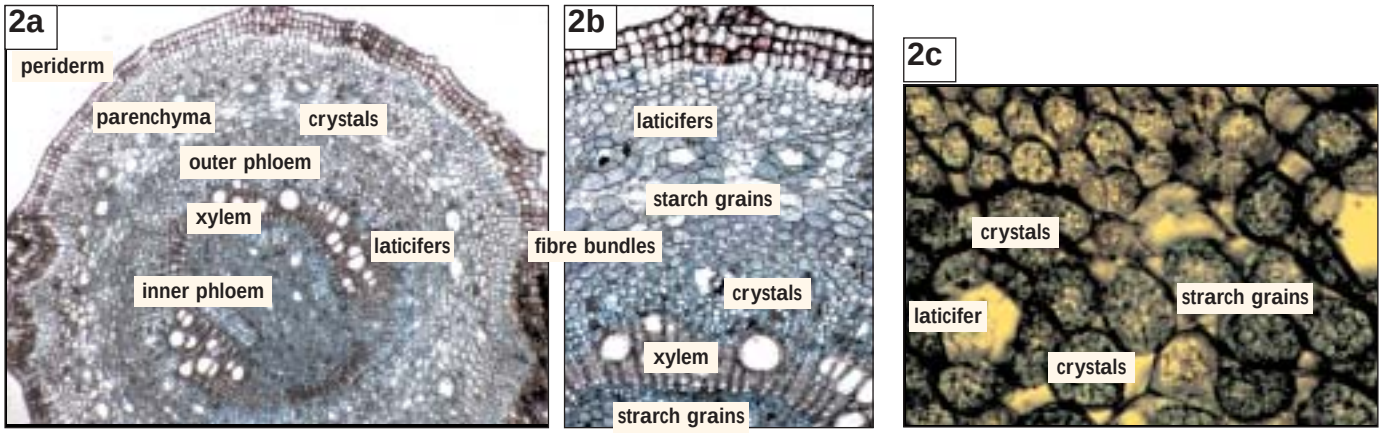

Figure 2a shows the entire section of the rhizome (40X magnification), **Figure 2b** shows a section of tissue between the periderm and the pith (100X); and, **Figure 2c** shows both starch grains and crystals within parenchyma cells (400X).

removed from the soil, the strong benzene-type smell given off indicates the presence of phenolic acids, known in other studies to be allelochemicals. Possible allelochemical interactions between Polymeria take-all and cotton were not investigated in this study, but have been suggested by growers.

In addition, competition for water and nutrients did not totally account for the reduction in growth of cotton grown with Polymeria take-all in another study. Accordingly, the possible allelochemical interaction between Polymeria take-all and cotton should also be investigated.

CONCLUSIONS

These studies showed:

- Auxin based herbicides should be effective against Polymeria take-all but further field trials are needed to confirm this.
- The large amount of starch stored in the rhizomes provides resources for regeneration of the plant after damage.
- Circumstantial evidence for the presence of allelochemicals that may reduce the growth of nearby plants such as cotton.

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Cultivation must be deep enough to destroy polymeria rhizomes