PIMELEA POISONING – THE PLANT ENIGMAS

R.G. Silcock, M. Fletcher, S. Chow and C. McNeale

Dept Primary Industries & Fisheries, Locked Mailbag 4, Moorooka, QLD 4105

Email: richard.silcock@dpi.qld.gov.au

INTRODUCTION

Pimelea trichostachya and *P. simplex* were confirmed as causal agents of St George/Marree disease in the 1970s (Clark 1971; Roberts and Healy 1971). These plants are native herbs that preferentially grow in the winter-spring period (Cunningham *et al.* 1981), are widespread over inland Australia (AVH 2008) and are regarded as annuals (Everist 1981; Dowling and McKenzie 1993). Poisoning seemed restricted to cattle and sheep and seemed associated with sparse pastures. Outbreaks of the disease were sporadic although some districts seemed to have some deaths ascribed to *Pimelea* almost every year. No vaccine or medication seemed effective (Dadswell *et al.* 1994).

After the 1970s, the next serious research was done in the early 1990s but it failed to find a vaccine and the factors controlling the incidence and growth of these plants in pastures was little better understood (Dadswell *et al*. 1994). They reported that the seeds of *P. trichostachya* germinated best at 25/15^{o}C, that seed dormancy was not prolonged and that no seeds germinated after a year in the field. Such a limited seed lifespan seems greatly at odds with the adaptation required of an arid zone annual.

A new wave of poisonings in 2005/2006 prompted renewed research into how to manage the plants to minimise the risk of poisoning. The research emphasis was on the level of toxin found in the different species, in the various parts of the plant and under different field conditions. Such analytical sophistication was unavailable when the last study was done. Current research put greater emphasis on the ecology of the plants which, despite many descriptions of plants, was very poorly known.

When popular rangeland field guides to plants were consulted, *P. trichostachya* and the others of this poisonous group was not mentioned by the Northern Territory book (DLHLG 1994) nor the Western Australian shrubland book (Mitchell and Wilcox 1994). However, they are described in equivalent books from South Australia (Kutsche and Lay 2003), NSW (Cunningham *et al.* 1981) and Queensland (Henry *et al.* 1995; Milson 1995, 2000). Despite the occurrence of *P. trichostachya* in all States and the NT (AVH 2008), it seems that it is not a practical problem in either WA or the NT.

IDENTIFYING THE CULPRIT PLANTS

Fig. 1. Leafy, 25cm tall *P. elongata* plant.

Part of the management problem is a lack of clear, consistent descriptions of the putative poisonous species *P. trichostachya*, *P. simplex* and *P. elongata*. In the 1970s, *P. simplex* was clearly differentiated as a species (Everist 1974; Cunningham *et al.* 1981) while *P. trichostachya* was regarded as having several forms. *P. elongata* was originally included under *P. trichostachya* and *P. simplex* subsp. *continua* was treated as a separate species *P. continua* (Aust. Systematic Botanl Soc. 1981; Everist 1981). From our observations there are misleading descriptions published by some sources. Often this is because a mixture of taxons is being described as only one taxon or the authors were trying to simplify obscure botanical terminology for grazing managers.

The problem for taxonomists is that their specimen plants have grown under widely differing conditions and on a variety of soils. Thus there is no way of clearly separating genetically controlled traits from environmentally driven features such as stem and leaf colour, leaf and fruit hairiness, plant size and degree of toxicity. Germinating seeds in a predictable fashion has been unachievable (Silcock *et al*. 2008) so studies of the species under identical conditions has been impossible to arrange. Very recently we achieved a possible breakthrough following suggestions by Dr Steve Adkins of UQ St Lucia to use gibberellic acid to stimulate germination. Preliminary tests with 3 species and seeds of different ages that have failed to germinate over 12 months (despite a wide range of stimulatory treatments such as hairy coat removal, scarification, heat treatment, cold stratification and smoke water), have achieved sizeable levels of germination after 3 weeks in moist conditions. The response is slow but pervasive and points to an acceleration of embryonic maturation occurring which does not happen by ageing of the seed alone. Dadswell *et al.* (1994) provided results which said that neither gibberellic acid nor several other germination promotants enhanced germination of *P. trichostachya* seeds but their seeds achieved about 80% germination if the seedcoat was cut, which ours did not. Cutting the seedcoat is extremely difficult to do without damage to the embryo, so it is not a practical method to use to produce large numbers of seedlings of similar age for growth studies.

FLORAL CHARACTERISTICS

There are some formal identification issues still to be resolved that centre on the type of hairs on the fruits/diaspores and the degree of elongation of the floral axis that occurs after flowering. All three species and their subspecies and types begin flowering with a dense compact inflorescence but some then elongate the rachis dramatically as the seeds ripen (*P. trichostachya* and *P. elongata*) while the others retain the ripening seeds on a densely packed rachis that is thicker than the subtending stalk (peduncle). On plants of the former two species, it is common to find elongated and compact inflorescences on the same plant and that simply means that the un-elongated ones are very immature. Under most growing conditions each inflorescence has a huge number of potential flowers (150-200) and if they all develop and set seed the axis can grow to over 15cm long by the time all seeds have ripened over more than a month and maybe as long as two months. With over 100 branches per plant possible and a prolonged period of branch initiation in good seasons, the development of new inflorescences can continue for 6-9 months on a single plant.

Several texts refer to the possession of green fruits and we find that to be misleading. The technicality of what is a fruit needs to be left aside in popular texts. What a stock owner sees after the flowers that produce the fruits have withered is a white or brown, usually hairy, “seed” that drops off when it is ripe or after the seed aborts if severe moisture stress hits. That seed, if mature, is actually a single embryo within a very dark, dimpled shell which is enveloped by the persistent (usually very hairy) floral tube which can, with some effort, be rubbed off. The dry hairy seeds look white, grey or pale brown, and only immature seeds of *P. elongata* ever appear green.

Early detection of a new crop of *Pimelea* seedlings would be very helpful but, there are several other species whose seedlings strongly resemble those of our target pimelea group. That is they emerge with opposite, non-hairy, bluish-green leaves on a single erect, pink stem. Hairs are commonly found on copper burr (*Sclerolaena* spp.) seedlings, which eliminates them, while others of the pigweed group (Portulacaceae) with thin leaves develop early branches. Daisy seedlings such as *Minuria* and *Rhodanthe* spp. can often be eliminated by their consistent possession of an alternate leaf arrangement up the stem while *Pimelea* seedlings only develop an alternate leaf arrangement after many pairs of opposite leaves initially. At this time, native flax (*Linum marginale*) and a raspweed (*Halorhagis* spp.) remain the most difficult to conclusively discount as young *Pimelea* seedlings.

GROWTH PERIODS

The plants are regarded as winter growers that flower in spring (Cunningham *et al.* 1981; Everist 1981). Prior dry summers are said to favour their recruitment (Milson 1995) and mostly they are regarded as annuals (Henry *et al.* 1995). This is largely true, especially in very low rainfall Central Australia and the southern rangelands where summer rainfall is scarce. However it may be what the plants do during summer which has as big an impact on poisonings as anything else. Our recent observations show that *P. trichostachya* and *P. elongata* can persist and continue to flower all summer under some conditions. Anecdotal observations also seem to show that flowering is not strongly controlled by daylength in *P. trichostachya* and *P. elongata* but that heavy shading can suppress flowering of *P. elongata*. Further controlled growth studies are needed to clarify the effect of daylength and shading on flowering. Also seedling recruitment of *P. trichostachya* and *P. elongata* can occur in mid-summer under cool moist conditions if primed seeds exist.

Hence a source of *Pimelea* toxin can exist in mid-summer as green plants, flowers or dropped seeds and not simply as fragments of dead, dry plants scattered on the soil surface as postulated by Clark (1971) and Kelly (1975). Such dead plant material has much lower simplexin concentrations (even zero in the branches and upper stem of *P. simplex* subsp. *continua*), than the seeds and flowers and green foliage. Hence a great deal more dead material of *P. trichostachya* would need to be consumed to equal the dose from green foliage. Perhaps dead *P. simplex* stalk without any retained seeds could be eaten without harm. The tip of each flower which bears the pollen and anthers and breaks off readily from ripe seeds also does not contain a significant amount of simplexin in *P. simplex* var. *continua*. So perhaps pollen may not be a source of toxin either.

There is also the probability that chronic low levels of ingestion could produce visible symptoms eventually, after the main growing season, and result in sick animals in mid-summer as has often been reported (Dadswell *et al.* 1994). Our studies have shown that the simplexin toxin is not readily taken up into water-based fluids, so leaching out into the soil and dust is not a likely poisoning mode but very fine plant dust and seeds could be a toxin source after green plants have disappeared.

MICROSITES FOR GROWTH

Fig. 2. *Pimelea* plants where runoff ponds.

The problem plants are often found in depressions or behind embankments where scarce water ponds, especially during relatively dry seasons. This applies particularly to *P. elongata* in the Adavale district where *P. simplex* subsp. *continua* grows adjacent to but away from where water ponds for prolonged periods. *P. elongata* shows an ability to survive short periods of inundation of its lower crown and stem. *P. trichostachya* seems very susceptible to fungal attack during prolonged wet summer weather. *P. simplex* appears ill-adapted to mid-summer heat and dead plants disappear (fall over or rot) more rapidly in summer than do those of the other two species.

Seedlings are extremely rare on very bare, smooth soil surfaces. *P. simplex* plants are very common around the base of stones and large gibbers in the Longreach district while *P. trichostachya* seedlings emerge in places where there is appreciable surface litter or in hollows left by blade ploughing. We believe this is due to the hairy seeds being blown there and trapped in the litter or under the edges of rocks or earth clods. Any light rain or heavy dew is then enough to virtually glue those seeds to the soil surface until they grow, are collected by ants or are covered by moving soil. The seedling roots do not have root hairs and so lack any mechanism to assist anchorage of a seedling emerging from seeds not incorporated into the soil surface.

SUMMARY

Our recent research has shown that virtually all poisoning cases reported in the past are explainable but possibly not always due to the factors proposed at the time. Uncertainty about identity of the plants involved in many cases means that the level of toxin that was ingested, inhaled or drenched is highly speculative. The exact source of the toxin may also have been misidentified – it could have been young plants or seedlings growing in mid-summer or seeds set in a protracted summer growing season rather than dust and dead plant fragments from the previous spring. We have no evidence of simplexin being held in surface soil adjacent to decaying *Pimelea* plants or weathering seeds. We still need better plant growth information but hopefully we can soon grow plants at will and thus be able to relate toxin levels to growing conditions and correlate animal symptoms with measured intake of simplexin or its related compounds.

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REFERENCES

Aust. Systematic Botanl Soc. (1981). Flora of Central Australia. Reed Books, Sydney.

AVH (2008). http://www.anbg.gov.au/cgi-bin/avh.cgi (Accessed 2/4/2008)

Clark, I.A. (1971). St George disease of cattle. *Aust. Vet. J.* 47: 123.

Cunningham, G.M., Mulham, W.E., Milthorpe, P.L. and Leigh, J.H. (1981). Plants of western New South Wales. Intaka Press, Sydney.

Dadswell, L.P., Graham, T.G., Newman, R.D., D'Occhio, M., Burton, D., and Schefe, C. (1994). Pimelea poisoning in beef cattle: plant ecology, epidemiology, therapeutic control and immunogen feasibility studies. Meat Research Corp. Final Report, Part 3: Technical Report. QDPI Project Report QO94021.

DLHLG (1994). Plants of the Northern Australian Rangelands. NT Dept Land, Housing & Local Govt., Darwin.

Dowling, R.M. and McKenzie, R.A. (1993). Poisonous Plants; a field guide. Qld DPI Info Ser. QI92035.

Everist, S.L. (1974). Poisonous Plants of Australia. Angus & Robertson, Sydney.

Everist, S.L. (1981). Poisonous Plants of Australia, rev edn. Angus & Robertson, Sydney.

Henry, D.R., Hall, T.J., Jordan, D.J., Milson, J.A., Schefe, C.M. and Silcock, R.G. (1995). Pasture Plants of southern inland Queensland. DPI Qld Info. Ser. QI95016.

Kelly, W.R. (1975). The pathology and haematological changes in experimental *Pimelea* spp. poisoning in cattle ("St George disease"). *Aust. Vet. J.* 51: 233-243.

Kutsche, F. and Lay, B. (2003). Field guide to the plants of Outback South Australia. Dept Water, Land & Biodiv. Consvn, Adelaide.

Milson, J. (1995). Plant identification in the arid zone. DPI Qld Info. Ser. QI94035.

Milson, J. (2000). Pasture plants of north-west Queensland. DPI Qld Info Ser. QI00015.

Mitchell, A.A. and Wilcox, D.G. (1994). Plants of the arid shrublands of Western Australia. UWA Press & WA Dept Agric., Perth

Roberts, H.B. and Healy, P.J. (1971). *Pimelea simplex* and St. George disease of cattle. *Aust. Vet. J.* 46: 123-124.

Silcock, R.G., Mann, M.B. and Morrissy, K.A. (2008). Ecology and herbicide tolerance of the native weeds that cause pimelea poisoning. Proc. 16th Aust. Weeds Conf., Cairns, May 2008 (in press).