Amaranthus palmeri where it was first confirmed in South Africa (April 2018) in a cotton field in the Douglas district. (Photographs by Dr Charlie Reinhardt)

'Wicked' US weed has put down roots locally

By Dr Charlie Reinhardt

The term 'wicked' weed is borrowed from the field of sociology where a wicked problem is defined as one without clear causes or solutions, and thus difficult or impossible to solve (Shaw, 2016, *Weed Science: Special Issue*, pp 552-558). Herbicide resistance is considered the epitome of a wicked problem: "The causes are convoluted by a myriad biological and technological factors, and are fundamentally driven by the vagaries of human decision-making."

In advocating a fresh approach for the effective management of herbicide resistant (HR) weeds, there is a growing school of thought that HR weeds must be understood as a multi-faceted socio-economic problem, not merely a biological phenomenon, and failure to do so guarantees that lack of progress in curtailing the evolvement of HR weeds will continue.

First population in South Africa

On 9 February 2018, I visited a farm in the Douglas district (Northern Cape) to investigate a case of an *Amaranthus* weed species that proved difficult to control in Roundup Ready™ cotton. By April 2018, this particular population was confirmed through herbarium and DNA analysis as that of *Amaranthus palmeri* (vernacular names: Palmer amaranth; careless weed), which is currently rated America's top 'wicked' weed in terms of its detrimental impact on maize, cotton and soya bean production.

Investigation on its current distribution in South Africa, its tolerance to various herbicides, and management options is underway in the South African Herbicide Resistance Initiative (SAHRI) research programme at the University of Pretoria.

Several *Amaranthus* species are common weeds in South Africa. Some types are indigenous and others are exotic (alien), but over time all have become naturalised in a variety of habitats, including crop systems. *Amaranthus* species are well known for their high nutritional value for animals and humans. The traditional name for plants in this group is *marogo* or *marog*.

Amaranthus hybridus (Cape or common pigweed) is the best known weedy type of *Amaranthus* in South Africa, and its origin also happens to be North America, except that it reached our shores many decades ago. Varieties of *A. hybridus* are grown as food crops for their grain and general significant nutritional benefits for livestock and humans.

Amaranthus palmeri is an annual (lifespan less than about twelve months) spring/summer season plant belonging to the family *Amaranthaceae*, which comprises 75 species worldwide. *A. palmeri* is indigenous in the northern parts of Mexico and the south-western areas of the US. In the past ten to 15 years of it being recognised as a particularly harmful weed in the US, it has spread rapidly to other parts of that country where it is especially problematic in maize, soya bean and cotton.

Origins and impact in the US

In the US, *A. palmeri* is classified as an unlawful (has to be controlled), noxious weed in the states of Delaware, Minnesota and Ohio – similar classification is currently considered in other states (Murphy *et al*., 2017). Information on *Amaranthus palmeri* and guides on its identification are freely available, for example: *www.wileyonlinelibrary.com DOI 10.1002/ps.4632; www.caes.uga.edu; www.agweb.com; bulletin.ipm.illinois.edu.*

Historically, *A. palmeri* was restricted to the semi-arid and arid south-western parts of the US, from where humans and their activities disseminated the weed seed – as contaminants of grain, through the movement of machinery and implements, as well as shifting agricultural practices – to the most important crop production areas of that country.

A national survey conducted in the US in 1989 identified it as a weed in southern US; in 1995, it was listed as the most noxious (harmful) weed in cotton in only two southern states, namely North and South Carolina; by 2009, it was recognised as the most noxious weed in cotton in nine southern states, and the second most noxious weed in soya bean. In 2014, *A. palmeri* had attained the status of most problematic and economically most important weed of maize, soya bean and cotton in the US as a whole.

Adaptability and control

Amaranthus palmeri is described as the US's number one weed because of its strong competitive ability with crops, and the consequent economic losses incurred due to the cost of special control measures and crop yield losses. This formidable weed is fittingly referred to as a 'wicked' weed because of its ability to thwart the best weed control measures and to establish rapidly across diverse environments.

In 2016, it was recorded for the first time in Argentina (Berger *et al.,* 2016, *Palmer Amaranth Identification and Documentation of ALS-resistance in Argentina. Weed Science Vol 64*, pp 312-320).

Because it originates from semi-arid regions in the US, this weed has the ability to wreak havoc in most parts of South Africa where crops are produced, perhaps with the exception of the winter rainfall region. But then again, it might happen that no region in the country, or the greater part of Southern Africa for that matter, will be spared this wicked weed.

Research in the US found that soya bean yields were reduced by 78% by *A. palmeri* when present from crop emergence, and at a density of 8 plants/m^2. Maize yields were reduced between 11 and 91% by 0,5 to 9 *A. palmeri* plants/m^2. This weed reportedly produces as many as 500 000 to 1 million seeds per plant.

Seeds can apparently survive for at least three years in soil and remain viable. The photosynthetic efficacy of *A. palmeri* is reportedly three to four times greater than that of cotton, maize and soya bean, and explains its successful competition with these crops.

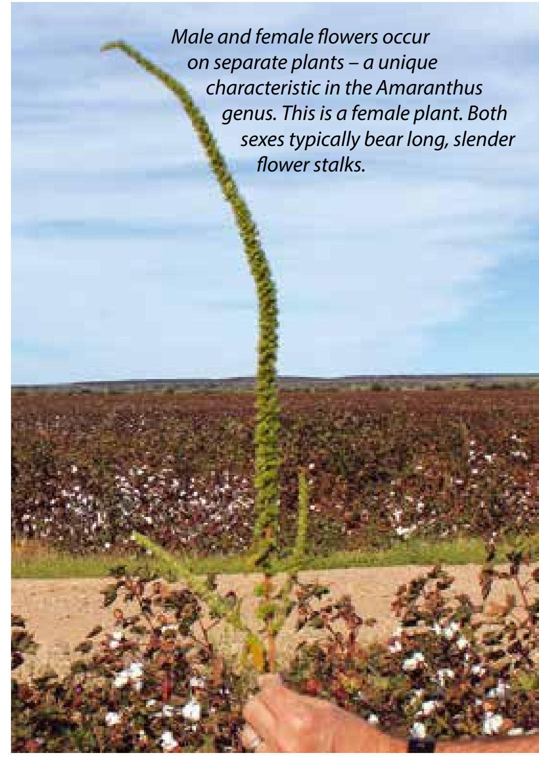
Experience in the US teach that successful control of this weed should be aimed at eradication and, at minimum, containment. Obviously, thorough surveys of crop fields in not only the Douglas district but also further afield, will form the foundation of management efforts. Not all is doom and gloom, because we can learn from US tactics and strategies developed over the last 10-15 years to contain this weed at levels that are manageable and tolerable at the same time.

Ability to evolve resistance

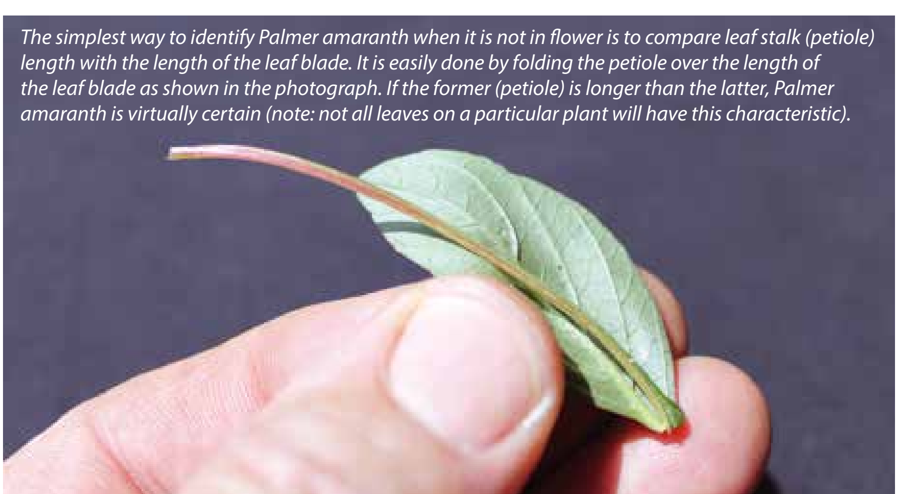
An exacerbating characteristic of *A. palmeri* is its ability to evolve resistance in a relatively short time to a range of herbicides. Palmer amaranth is dioecious (sexes occur on separate plants), which means outcrossing is forced and makes for high genetic diversity in this species. This trait makes it highly adaptable to diverse environments and promotes rapid evolvement of herbicide resistance across herbicide modes of action.

At this stage in the US, the weed has developed resistance to five groupings of herbicides, classified according to their mechanism of action, namely: protoporphyrinogen oxidase (PPO) inhibitors, photosynthesis (PSII) inhibitors, acetolactate synthase (ALS) inhibitors, microtubule disruptors, and to glyphosate herbicide, an EPSPS enzyme inhibitor.

In the US, different Palmer amaranth populations show variable resistance to the aforementioned herbicide mechanisms of action, with the most common type of resistance to ALS inhibitors and glyphosate. The rendering ineffective of such major herbicide groups has had nearly incalculable crippling consequences for especially maize, cotton and soya bean production in the US. We will do well to take heed and make utmost speed with its management!



Male and female flowers occur on separate plants – a unique characteristic in the Amaranthus genus. This is a female plant. Both sexes typically bear long, slender flower stalks.



The simplest way to identify Palmer amaranth when it is not in flower is to compare leaf stalk (petiole) length with the length of the leaf blade. It is easily done by folding the petiole over the length of the leaf blade as shown in the photograph. If the former (petiole) is longer than the latter, Palmer amaranth is virtually certain (note: not all leaves on a particular plant will have this characteristic).

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