Synthetic Auxin Resistance in Wild Radish

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HERBICIDE RESISTANCE ACTION COMMITTEE

Auxin Resistant Wild Radish

Wild radish is the second most economically important weed of crops in Australia and a common weed of crops globally. It has evolved resistance to five mechanisms of action, the last being to synthetic auxins in 1999 in western Australia. Resistance to synthetic auxins in wild radish has not been found outside of Australia, however resistance to ALS inhibitors has been found in the cereal cropping regions of Brazil, and south Africa.

Levels of Resistance and Cross-Resistance

The level of resistance to 2,4-D is low (between 3 and 5 fold) and plants sprayed with the recommended rate of 2,4-D in crop appear to be severely stunted (with a 75% reduction in biomass compared to unsprayed plants), however they survive, reduce crop yields, and set viable seed.

Mechanism of Resistance

It is believed there are a combination of at least two mechanisms that work together to confer synthetic auxin resistance in wild radish. 2,4-D does not translocate out of the treated leaf in the resistant biotype but does in the susceptible. It is possible that 2,4-D is being sequestered into vacuoles or the apoplast. In addition, research on 2,4-D treated plant extracts have shown that the resistant wild radish biotype metabolizes about 40% of 2,4-D into three different metabolites.

Rate of Spread

Synthetic auxin resistant wild radish is unusual in that it is one of the few synthetic auxin resistant weeds that have become widespread and of significant economic importance. Synthetic auxin resistant wild radish is found over large areas of the southern Australian cropping region.

Resistance to Other MOA's

In addition to synthetic auxin resistance, wild radish has evolved resistance to four other herbicide mechanisms of action.

1. ALS-inhibitors — first identified in 1997, ALS inhibitor resistant wild radish occurs in South Africa, Brazil and the Australian states of NSW, SA, VIC, and WA. Resistance levels are high and have been shown to be due to a number of target site mutations.
2. PDS inhibitors (Carotenoid biosynthesis inhibitors) — first identified in 1998 occurs in the Australian states of SA, and WA.
3. PSII-inhibitors — identified in Western Australia in 1999. The levels of resistance to atrazine and simazine are very high (up to 160 fold) suggesting a target site mutation.
4. Glyphosate — reported in Western Australia in 2010. Resistance levels are relatively low at about 4 to 5 fold.

Multiple Resistance

Multiple resistance in wild radish is already common in southern Australia and presents a serious threat to crop production in this region. An extensive survey of 500 cropping fields in Western Australia (2007) found that 60% of wild radish populations had synthetic auxin resistance, 54% of the populations had resistance to acetolactate synthase inhibiting herbicides, 46% had resistance to phytoene desaturase inhibitors, and 15% had resistance to photosystem II inhibitors. What is even more concerning is that 58% of populations had resistance to at least two herbicide mechanisms of action, and 7% of wild radish populations had resistance to all 4 herbicide mechanisms of action. Only 17% of wild radish populations remained susceptible to all the herbicides tested. With the identification of glyphosate resistant wild radish in Western Australia in 2010, undoubtedly there will be populations that have resistance to all five herbicide mechanism of action which leaves very few herbicidal options for control of wild radish in crops.

Wild radish seedling at an appropriate size for post-emergence herbicide application.

Best Management Practices

Integrated weed management including herbicide rotation, mixtures, and cultural/ mechanical controls should be practiced to delay the selection of synthetic auxin resistant wild radish. The fact sheet "Synthetic Auxin Resistant Weeds" provides more detail on how to delay and mitigate resistance. Specifically for wild radish there are two main non-herbicidal strategies to reduce population numbers.

The first is through harvest weed seed control (see inset to right), and the second is through increasing crop competition. Recent studies on crop competition between wild radish and wheat in southern Australia have shown that increasing wheat density to between 200 and 400 plants m^{-2} reduced wild radish seed production and reduced crop yield loss. Wheat competition alone can account for more than 40% reduction in wild radish biomass.

Facts about Wild Radish

SCIENTIFIC NAME

Raphanus raphanistrum

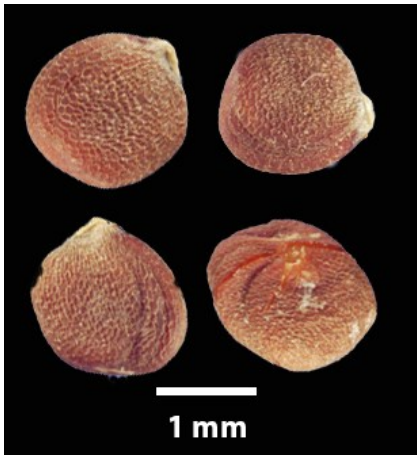
OTHER COMMON NAMES

Jointed charlock

Wild radish is a native of the Mediterranean region and is a major crop weed in many regions of the world. It is a strong competitor for light, nutrients, water and also interferes with harvesting (through blockage of equipment) and is a host to important crop pests. Wild radish populations have been shown to cause more than 50% reduction in wheat yield.

SEED PRODUCTION AND DISPERSAL

Wild radish is a winter annual plant with a very high reproductive capacity, seed dormancy and seed bank longevity. Under competition from wheat, wild radish can produce more than 12,000 seeds m^{-2}. It is critical to control early-emerging plants not only because they cause the greatest yield reduction in wheat but they produce the greatest number of seeds these seeds are more dormant than seeds from the late-emerging plants.



Harvest Weed Seed Control

Progress has been made in Australia on weed seed harvesting techniques, and this may be an effective way to reduce wild radish populations. These techniques, which include chaff carts, narrow windrow burning, baling during harvest, and the Harrington Seed Destructor enable collection and subsequent destruction of weed seeds in chaff that would traditionally be spread back onto the field. The Harrington Seed Destructor™ is towed behind the combine and has been shown to destroy 93% of wild radish seed during cereal harvest. Chaff collection provides 95% removal of wild radish seed from the field, and narrow windrow burning can destroy 99% of wild radish seed.

Harrington Seed Destructor™

REFERENCES

Cheam, A. H. 1986. Seed production and seed dormancy in wild radish (*Raphanus raphanistmm* L.) and some possibilities for improving control. Weed Research Volume 26. 405 413.

Walsh M. J., Maguire N., and S. B. Powles. 2009. Combined effects of wheat competition and 2,4-D amine on phenoxy herbicide resistant *Raphanus raphanistrum* populations. Weed Research 49, 316–325.

Walsh M. J., Owen M. J. and Powles S.B. 2007. Frequency and distribution of herbicide resistance in *Raphanus raphanistrum* populations randomly collected across the Western Australian wheatbelt. Weed Research 47, 542–550.

Walsh M., Newman P., and S. Powles. 2013. Targeting Weed Seeds In-Crop: A New Weed Control Paradigm for Global Agriculture. *Weed Technology* 27:431–436