PARAQUAT RESISTANCE IN BARLEY GRASS (*HORDEUM GLAUCUM*) FOLLOWING MINIMUM TILLAGE USE IN A CONTINUOUS CROPPING SYSTEM

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Summary Paraquat is a contact herbicide which is widely used for control of annual weeds in pasture and as a pre-planting herbicide in zero and minimum tillage systems in Australian agriculture. Extensive use of paraquat has resulted in the evolution of resistant weed biotypes in Australia and around the world. In Australia, paraquat resistant weed populations have only been reported from lucerne fields. This report details paraquat resistance in two populations of *Hordeum glaucum* from continuous cropping systems where paraquat and diquat were used to control weeds prior to sowing. In pot experiments, these populations proved to be very resistant to paraquat and were not controlled by 3200 g a.i. ha^{-1} while susceptible biotypes are controlled by as little as 12.5 g a.i. ha^{-1}.

INTRODUCTION

Paraquat and diquat have numerous agricultural uses as non selective, rapid acting herbicides. Paraquat binds to soil colloids irreversibly and normally has no soil activity. This makes paraquat ideal for use as a pre-sowing herbicide. Paraquat is also used for post-emergent weed control in crops such as lucerne or orchards and vineyards. Resistance to paraquat has been reported following 5 to 10 applications of this herbicide each year for five or more years (Watanabe *et al.* 1982) or annual applications for 12 years or more (Powles 1986). In Australia, all previously reported case of resistance to paraquat have occurred in lucerne fields where paraquat and diquat were used once annually as the only method of weed control (Preston 1994).

Paraquat is widely used in Australia in minimum tillage systems for knock-down weed control before crop-seeding. In 1995, two separate cases of failure of paraquat to control *H. glaucum* were reported following use of paraquat for about 15 years in continuous cereal rotations. This report describes experiments demonstrating that these populations are resistant to paraquat.

MATERIALS AND METHODS

Seeds of the resistant biotypes of *Hordeum glaucum* were collected from two different paddocks in South Australia used for continuous cereal cropping for the last 15 years. Paraquat and diquat were applied once annually in these paddocks every year prior to sowing the cereal crops. The susceptible biotype was obtained from a field with no history of herbicide use. The seedlings were germinated on Agar and transplanted to 18 cm pots containing potting soil and maintained outdoors during winter, the normal growing season for this species.

The susceptible and resistant plants were sprayed with various rates of paraquat at the 3–4 tiller stage. Herbicide was applied in a laboratory spray cabinet. The plants were sprayed in the late afternoon, kept indoors overnight and placed outdoors on the following morning to maximize the effects of paraquat (Brian and Headford 1968). The plants were visually scored for survival at four weeks after spraying, then harvested and the dry weight determined.

To determine the response of these biotypes to other herbicides, plants where sprayed with the recommended rates of diquat, oxyfluorfen and fluazifop-butyl.

There were four replicates in each experiment and the experiment was conducted three times.

RESULTS

As shown in Figure 1, the susceptible biotype was readily controlled by very low doses of paraquat. More than 90% of plants were killed after application of 12.5 g ha^{-1} which is much less than the recommended rate of

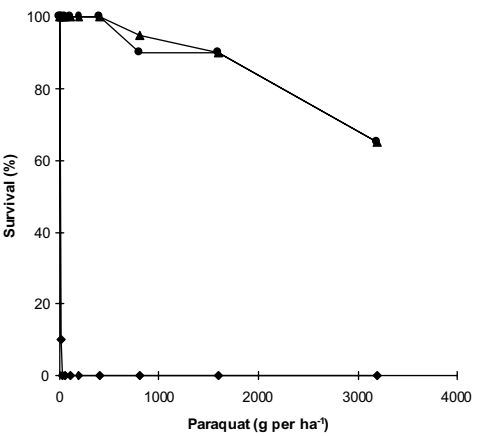

Figure 1. Effect of paraquat on survival of two resistant (SHG3 and SHG4) and one susceptible biotype of *H. glaucum.* (SHG3 ●, SH4 s, S ◆).

200 g ha^{-1}. The resistant plants in contrast were not controlled even at high doses of paraquat. The resistant biotypes were not controlled following application of 3200 g ha^{-1} which is 16 times more than the recommended rate. Obviously these biotypes are highly resistant to paraquat.

To determine the susceptibility of these biotype to other herbicides, the resistant and susceptible plants were sprayed with the recommended rates of alternative herbicides. The resistant and susceptible biotypes were found to be equally susceptible to these herbicides and to be controlled at recommended rates. However, the resistant biotypes were resistant to diquat.

This is the first report of paraquat resistance, worldwide, following the use of this herbicide in minimum tillage cropping systems.

REFERENCES

Brian, R.C. and Headford, D.W.R. (1968). The effect of environment on the activity of bipyridylium herbicides. Proceedings 9th British Weed Conference, pp. 108-14.

Powles, S.B. (1986). Appearance of a biotype of the weed, *Hordeum glaucum* Steud., resistant to the herbicide paraquat. *Weed Research* 26, 167-72.

Preston, C. (1994). 'Mechanisms of resistance to herbicides interacting with photosystem I'. *In* 'Herbicide Resistance in Plants: Biology and Biochemistry', eds. S.B. Powles and J.A.M. Holtum. (Lewis Publishers, Chelsea, MI).

Watanabe, Y., Honina, T., Itoh, K. and Miyrashara, M. (1982). 'Paraquat resistance in *Erigeron philadelphicus*'. *Weed Research* (*Japan*) 27, 49-54.