

Temperature influences on the level of resistance to paraquat in a biotype of *Hordeum leporinum* Link.

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Summary

A biotype of barley grass (*Hordeum leporinum* Link.) from a lucerne field near Ouse, TAS was found to be resistant to paraquat. The level of resistance in this biotype decreased when the plants were sprayed in the summer from about 200 times to about three times that of the susceptible biotype. This decrease was shown to be due to the warmer temperatures experienced during summer. The biochemical mechanism responsible for this temperature differential has not been determined but it may be directly related to the mechanism of resistance in this biotype.

Introduction

Environmental influences have been long recognised to alter the effectiveness of bipyridyl herbicide action. Bipyridyl herbicide translocation is reduced in the light (1, 2) as a result of the phytotoxic action of the herbicide and increased humidity promotes herbicide action by increasing uptake (3, 4). Temperature effects on paraquat activity have not been extensively studied, however, cooling plants to 0°C increased paraquat effectiveness (4), but another study (5), which examined cell membranes, suggested that paraquat would be less effective at low temperatures.

In 1989 a biotype of *Hordeum leporinum* Link. was collected from a lucerne field near Ouse, TAS which had received a once annual application of paraquat and diquat as the only form of weed control for the previous 12 years. A susceptible biotype was collected from a nearby pasture with no history of bipyridyl herbicide use. During testing for resistance of this biotype it was observed that a large seasonal difference occurred in the level of resistance obtained. This study has investigated the effects of seasonal factors on the observed level of resistance and has found that the decreased level of resistance observed in summer is due to the higher ambient temperature.

Materials and Methods

Plants were grown in pots outdoors in Adelaide either in winter or summer and were sprayed with herbicide in a laboratory spray cabinet. Plants were kept indoors overnight after spraying before being returned to the field. Thirty days after spraying surviving plants were scored. Light intensity and temperature were manipulated in the field by growing plants in the sun or in a shade-house in summer or winter. The average temperature and light intensities recorded at 2 pm during this experiment were: winter, sun 15°C, 137 $\mu\text{E}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$; winter, shade 15°C, 32 $\mu\text{E}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$; summer, sun 25°C, 2100 $\mu\text{E}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$; and summer, shade 25°C, 430 $\mu\text{E}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$.

Results and Discussion

The *H. leporinum* biotype from the lucerne field proved to be very resistant to paraquat if sprayed during the winter compared to

the susceptible biotype (Figure 1A). If plants were sprayed in the summer the level of resistance in this biotype was dramatically reduced (Figure 1B). Spraying at 800 g a.i. ha⁻¹ paraquat, a rate which in winter the resistant biotype survives, resulted in 100% mortality of this biotype in the summer. A small increase in the level of tolerance of the susceptible biotype to low rates of paraquat could also be observed (Figure 1).

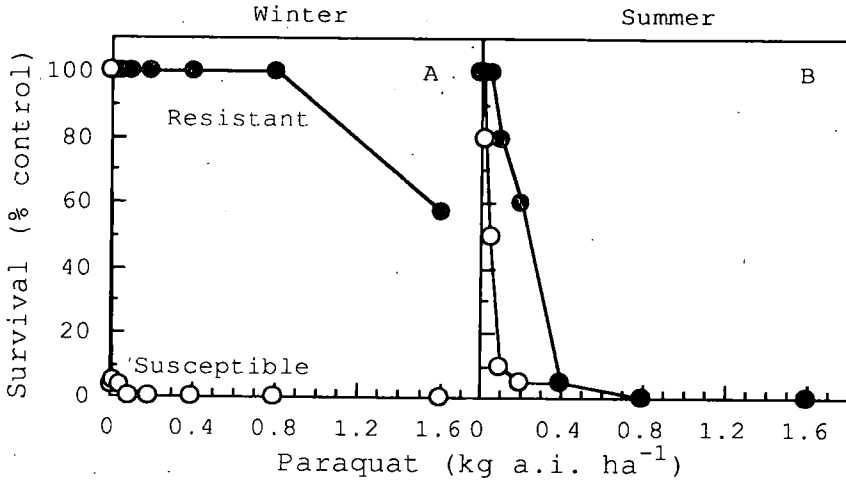


Figure 1. Response of paraquat-resistant (●) and -susceptible (○) biotypes of *H. leporinum* to paraquat application in winter (A) and summer (B).

Increased light intensity is known to reduce the effectiveness of paraquat (1, 2), however, it was uncertain how spraying in summer could reduce resistance to paraquat. An experiment was designed to examine the effects of temperature and light intensity in the field on the level of resistance. Resistant and susceptible biotypes were grown and sprayed with paraquat during winter or summer in sunlight or in a shade-house. The shade-house reduced the light intensity by about 80% in both summer and winter, but had little effect on temperature. The results of these experiments showed that temperature was clearly the dominant influence on the observed level of resistance to paraquat (Figure 2). In summer the resistant biotype was less resistant to paraquat regardless of whether plants were grown in the sun or shade-house. The susceptible biotype, in contrast, showed an increased tolerance of paraquat in the summer (Figure 2D) in both the sun and shade-house. These differences in response to elevated temperature are not a consequence of different environmental backgrounds as the two biotypes were collected from the same locality. Paraquat effectiveness was increased in shade-house-grown resistant plants in both winter and summer and for susceptible plants in winter. The reduced effectiveness of paraquat in the sun can be attributed to reduced movement of the herbicide as a result of light-induced leaf damage (1,2).

The biochemical mechanism for this high temperature-induced decrease in the level of resistance to paraquat of the resistant biotype is not understood. It is not a result of increased heat sensitivity of the photosynthetic apparatus of the resistant biotype and the interaction of paraquat with the active site, Photosystem I,

is not increased at higher temperatures (data not shown). Due to the marked effect that temperature has on the level of resistance we suggest that this effect is directly related to the mechanism of resistance in this biotype. Therefore, solving the basis of the temperature influence on the level of resistance could solve the mechanism of resistance in this biotype.

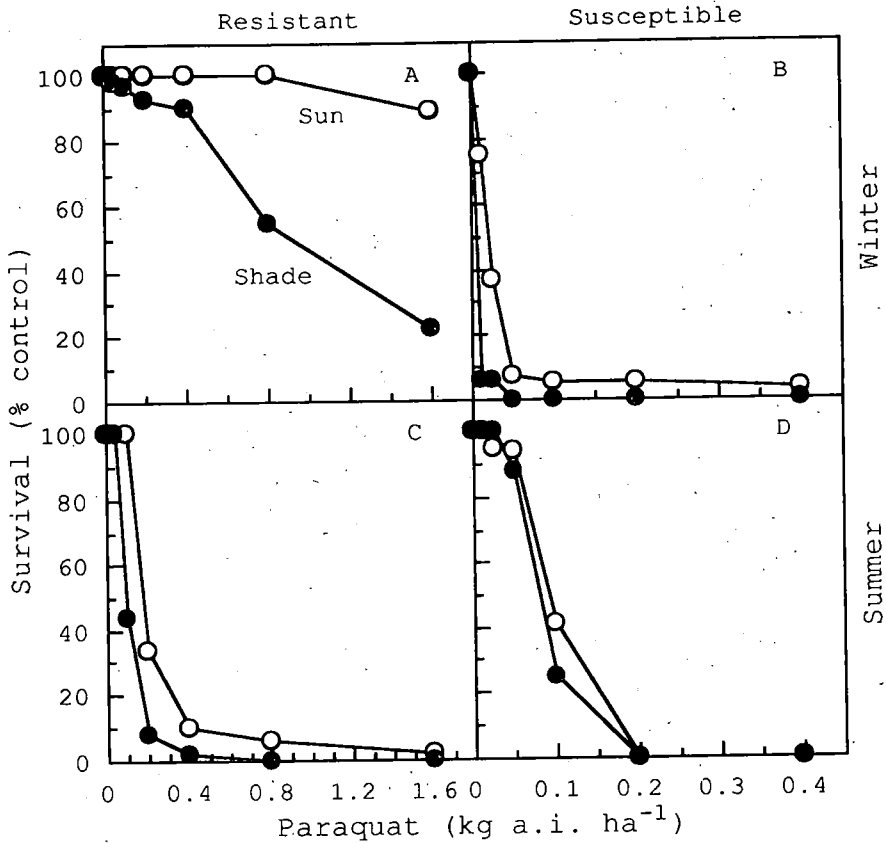


Figure 2. Response of resistant (A,C) and susceptible (B,D) biotypes of *H. leporinum* to paraquat in winter (A,B) and summer (C,D) when plants were grown in sun (O) or shade (●).

References

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