THE BIOLOGY OF *LOLIUM*: WILL *L. TEMULENTUM* BE SIMILAR TO *L. RIGIDUM* AND THREATEN CROP ROTATIONS IN WESTERN AUSTRALIA?

W.M. Blacklow[1] and C. Andreasen[2]
[1] The University of Western Australia, Nedlands WA 6009, Australia
[2] The Royal Veterinary and Agricultural University, Copenhagen, Denmark

Summary. Each year in Western Australia more than 20 farms deliver wheat and barley infested with drake (*L. temulentum* L.). The seeds can be poisonous and contaminated grain is unacceptable for overseas markets. Drake may be more widespread than realised presently because it can be misidentified as a variant within the annual ryegrass complex (*L. rigidum* and its hybrids). Biotypes of *L. temulentum* from Western Australia have innate and enforced seed dormancy; vigorous seedling growth; high seed production. Unless special cleaning measures are used the weed is sown with crops established from seed saved on the farm. *L. temulentum* produced less regrowth after defoliation than *L. rigidum* and may be sensitive to grazing. *L. temulentum* is unlikely to become more widespread in Western Australia if clean seed is sown and an integration of methods is used for its management, including a phase of grazed pasture. However, the awned biotype of drake (*L. temulentum* var. *temulentum*) which is prevalent in Western Australia may be more able to survive the current farming systems than the biotypes introduced into other parts of Australia and which have not flourished.

INTRODUCTION

Each year in Western Australia more than twenty farms produce barley and wheat which is infested with drake (*Lolium temulentum* L.). The seeds of drake can be poisonous (4) and contaminated grain needs expensive recleaning to meet the low, or zero, tolerances of markets. Drake grows throughout the wheatbelt of Western Australia but it seldom reaches densities that cause concern to many farmers. However, the incidence of the weed is unpredictable and those that receive grain for export markets do not want the weed to increase. Elsewhere in Australia drake is rare or extinct (10) and in other countries it is an endangered species (7) or a weed that needs to be controlled (12).

The variable incidence and status of drake is intriguing, particularly when compared with the widespread and troublesome annual ryegrass (*Lolium rigidum* L. and its hybrids). In part, the problem is due to difficulties with identification of species and hybrids within the *Lolium* genus. However, regional differences will be due to variations within, and between, the *Lolium* species and their interactions with climates, soils and farming systems. This paper develops several hypotheses to explain the current distributions of drake, and to predict the factors which could cause it to increase in Western Australia. Comparisons with *Lolium rigidum* may strengthen the outcomes of the investigation of drake and also provide further insights into the nature and distribution of weeds.

MORE WIDESPREAD THAN CURRENTLY RECOGNISED?

Drake may be more widespread than currently recorded but identified incorrectly as *Lolium rigidum*. Kloot (10) concluded that there were four *Lolium* species that could be weeds of Australian agriculture. Three of the species outcross (*L. perenne*, a perennial; *L. multiflorum*, a short-lived perennial; *L. rigidum*, an annual) and produce interbreeding hybrids which form populations with individuals that have all possible characteristics of the parent species. These

crosses with *Lolium rigidum* retain the annual habit and could, therefore, cohabit sympatrically with the annual, self-pollinating *Lolium temulentum*. Consequently, *Lolium temulentum* could be in the same fields as *Lolium rigidum* and its hybrids and, if unrecognised, identified incorrectly as "annual ryegrass" (*L. rigidum*).

All annual *Lolium* species are characterised by glabrous, shiny leaves. Compared with *Lolium rigidum*, our Western Australian collections of *Lolium temulentum* have seedlings with larger more erect leaves and only a few tillers. However, individuals within *Lolium rigidum* populations were as large and erect as *Lolium temulentum*. Differences in the morphology of the inflorescence and seed (caryopsis plus adhering glumes) make it possible to distinguish between *Lolium rigidum*, and its hybrids, and *Lolium temulentum* (10). The spikelets are more widely spaced on the spike, particularly at its base, and the seeds are larger and ovoid (Fig. 1). The long awns of drake (*L. temulentum* var. *temulentum*) differ from its awnless biotype (*L. temulentum* var. *arvense* [With.] Liljebl) and the awnless *L. rigidum* and its hybrids.

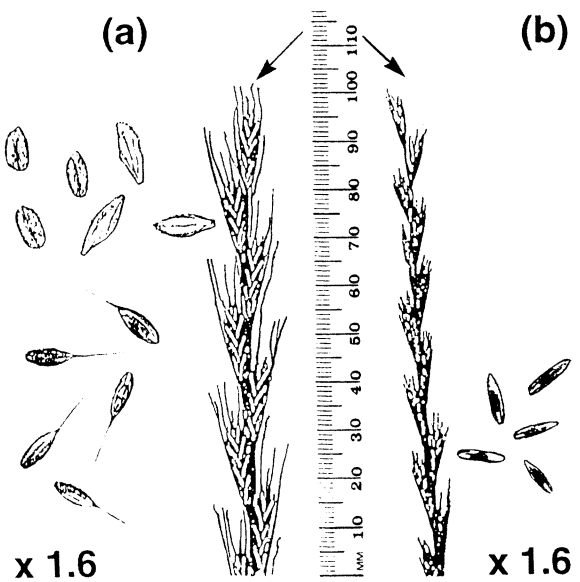

Figure 1. The terminal spikelets and seeds (caryopsis plus adhering glumes) of the awned biotype of drake (a) and of annual ryegrass (b).

BIOTYPE INTRODUCTIONS OF DIFFERENT ADAPTABILITIES?

Drake may have adapted successfully to Western Australia because the introductions came from the Mediterranean regions of Europe. It is known that drake is adapted to regions from northern Europe, with summer growth and freezing winters, to Mediterranean regions, with winter growth and long dry summers (9). Perhaps the lack of persistence of drake in other parts of Australia is because the introductions to those parts were from the more northern regions of Europe and less adaptable to the long, dry summers of southern Australia.

It would be expected that seed dormancy for summer survival would be an important attribute for success in Mediterranean climates. It was suggested that drake has no dormancy (5; 8) but drake from Western Australia has both innate and enforced dormancy (2). These differences in dormancy may be due to sources of seed with that from Western Australian produced by biotypes better adapted to Mediterranean climates. Annual ryegrass is well adapted to the Mediterranean climates of southern Australia and it has innate and enforced dormancy also (6).

The responsiveness of flower initiation by drake to photoperiod and vernalisation differs among biotypes (5). A summer annual biotype (Ceres) requires an exposure of only one day with a photoperiod greater than nine hours to switch plants from vegetative to reproductive growth. A winter biotype from Turkey, however, had a critical photoperiod of more than 14 hours (5). The photoperiod requirements of the Western Australian biotypes for flower initiation are not known but plants grown in late summer initiated reproductive growth whereas *Lolium rigidum* continued to make vegetative growth (Fig. 2). The winter biotypes of drake respond to vernalisation whereas the summer types are unresponsive (1; 5). *Lolium rigidum* responds also to photoperiod and vernalisation but Mediterranean types had a low vernalisation response (3).

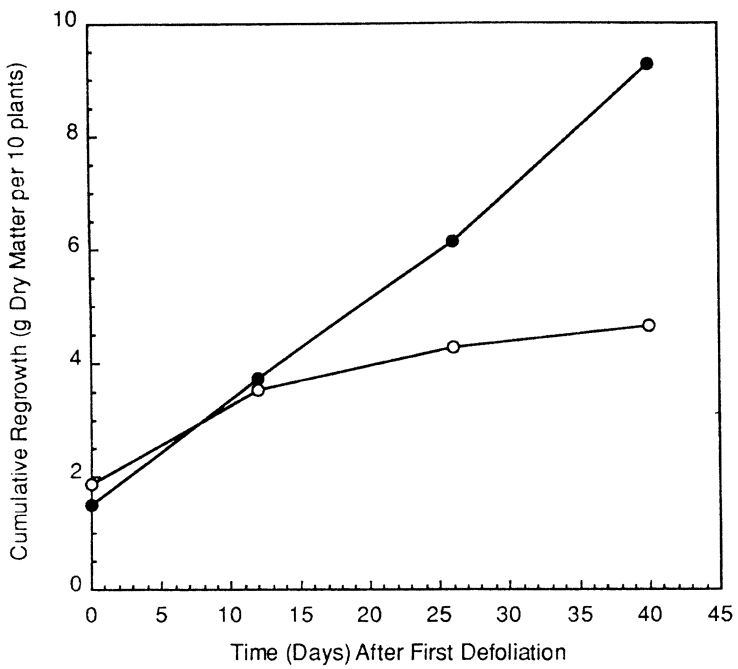

Figure 2. The response of *Lolium* species to frequent defoliation during February-March 1993 in a daylight phytotron, Perth, Western Australia (32° South Latitude; 13-14 hours daylength; 25°C/15°C day/night temperatures) of the awned biotype of drake (o) and of annual ryegrass (•). The mean coefficient of variation for a datum point (n=4) was 10%.

ENCOURAGED BY FARMING SYSTEMS?

Drake may have adapted more successfully to regions of Western Australia because of the types of farming systems practiced there. Discussions with farmers who have infested grain suggests that drake is more of a problem on light textured soils that are cropped frequently without the use of herbicides for grass control, and without a grazed pasture in rotation with the cereal crops. Additionally, farmers in these regions routinely save a portion of their crop as seed for subsequent crops and if infested with drake then the weed is sown with the crop. The awned biotype of drake seems more persistent than the awnless type which supports the proposition that drake is an obligate weed of cereals, since it would be more difficult to separate from cereal grains by seed-harvesting machinery. For example, accessions in the Herbarium of Tasmania are only the awnless biotype and the species may be extinct in that State. In Western Australia, however, cereal seed is contaminated by the awned biotype of drake and the awnless biotype has not been seen recently.

Herbicides, and their rotations, are used widely in crop rotations across southern Australia for weed control. The expectations would be that current methods of cultural and chemical control of grass weeds would control drake also. However, it was suggested (2) that delayed germination of drake by warm temperatures may enable it to escape early cultural and chemical treatments. Resistance of annual ryegrass to herbicides is of major concern across southern Australia (11) but we have very little information on the response of drake to herbicides.

CONCLUSIONS

The persistence of drake in Western Australia may be due to the introduction of adaptable biotypes from Mediterranean regions of Europe. These adaptable types may have been encouraged by the farming systems of low inputs of herbicides, minimum tillage, rotations that have low grazing pressures and infrequent use of crops other than cereals, and the use of seed from crops infested with drake. The required elimination of potentially poisonous contaminations of drake will require its recognition as a different species from annual ryegrass, a greater intolerance of its presence in crops, and a reversal of those factors that encourage it. The hypotheses proposed in this paper require validation if management programs are to be based on sound knowledge of the biology of the weed.

ACKNOWLEDGEMENTS

Lisa-Jane Blacklow managed the simulated grazing experiment, assisted with a literature search and prepared the Figures. Barbel Gerowitt drew our attention to the endangered species status of drake in Germany and David Cooke, Peter Kloot and Dennis Morris provided information on the status of drake in South Australia and Tasmania.

REFERENCES

1. Arumuganathan, K., Dale, P.J. and Cooper, J.P. 1991. Annals of Bot. 67, 173-180.
2. Chanprasit, P. and Blacklow, W.M. 1990. Proc. 9th Aust. Weeds Conf., Adelaide. p. 429.
3. Cooper, J.P. 1960. Ann. Bot. 24, 232-246.
4. Dannhardt, G. and Steindl, L. 1985. Planta Medica. 3, 212-214.
5 Evans, L.T. 1969. *Lolium temulentum* L. In: The Induction of Flowering. (Ed. L.T. Evans) (Macmillan of Australia). pp. 328-349.

6. Gramshaw, D. 1972. Aust. J. Agric. Res. 23, 779-787.
7. Hofmeister, H. and Garve, E. 1986. Lebensraum Äcker Pflanzen der Acker und ihre Ökologie. pp. 223-235.
8. Holm, L.G., Plucknett, D.L., Pancho, J.V. and Herberger, J.P. 1977. *Lolium temulentum* L. In: The World's Worst Weeds. (University Press of Hawaii). pp. 314-319.
9. Humphries, C.J. 1980. *Lolium*. In: Flora Europaea. Vol. 5. (Eds. T.G. Tutin *et. al.*) (Cambridge Univ. Press). pp. 153-154.
10. Kloot, P.M. 1983. Aust. J. Bot. 31, 421-435.
11. Powles, S.B. and Howat, P.D. 1990. Weed Technology 4, 178-185.
12. Saavedra, M., Cuevas, J., Mesa-Garcia, J. and Garcia-Torres, L. 1989. Crop Protection 8, 181-187.