ABSTRACT

Wilcox, Douglas Howard. Ph.D., The University of Manitoba, October, 1994. Models of Interference in Monocultures and Mixtures of Wheat (Triticum aestivum L.) and Quackgrass (Elytrigia repens (L.) Nevski.). Major Professor: Dr. I.N. Morrison.

Quackgrass is the most serious perennial grassy weed of wheat in Manitoba. Field experiments and surveys investigating the nature and extent of interference in monocultures and mixtures of quackgrass and wheat were conducted over the years 1987 to 1989 at Portage La Prairie, Manitoba, Canada.

Intraspecific and interspecific interference between spring wheat and quackgrass was investigated in the field using an additive series design consisting of five replacement series proportions at total stand densities of 75, 150, and 300 plants m^{-2}. A revised synthetic no-interaction analysis determined that wheat was superior to quackgrass in both intraspecific and interspecific interference and that niche differentiation was large. Quackgrass reproductive variables were less sensitive to interspecific interference than were vegetative variables.

Surveys of commercial fields of spring wheat infested with quackgrass were conducted using a dynamic stratified random sampling design in which systematic samples were taken at approximately 30, 60 and 93 days after planting. Wheat yield loss, as a percentage of

weed-free yield, ($Yw_{\%}$) was related to spring quackgrass shoot counts/m^{-2} (Qs) by a rectangular hyperbolic model of the form

$$Yw_{\%} = 98.7(1-0.433(Qs)/100(1+(0.433(Qs)/193.7))).$$

Wheat kernel weight was the wheat yield component most influenced by quackgrass infestation. In quackgrass populations the majority of new rhizome production occurred during wheat senescence and biomass partitioning to heads increased as quackgrass infestation increased. Allometric models of the relationship between quackgrass parts were site specific and generally became more accurate the later the sampling date.

A set of models relating spring quackgrass infestation to yield losses in hard red spring wheat, flax, and polish canola were combined with allometric models in a multi-year spreadsheet (Lotus 1-2-3, v 3.1) model. Simulations run using the multi-year model demonstrated the potential of a spreadsheet model for assisting in weed control decisions.

FOREWORD

This thesis was written in manuscript style following the format of Weed Science. It is expected that manuscripts 1 to 3, and appendix 1, will be submitted for publication in Weed Science and that manuscript 4 will be submitted for publication in another refereed journal.

The bulk of the thesis text was printed using a 12 pt Adobe Garamond typeface with headers and captions printed using a 12 pt Franklin Gothic Condensed typeface.

INTRODUCTION

Wheat has been produced in Manitoba since the arrival of the Selkirk settlers at Fort Garry in 1812. However, it was not until 1906 that quackgrass (*Elytrigia repens* (L.) Nevski.), a weed introduced to eastern North America from Europe around 1663, was reported as occurring in Manitoba fields (Alex, 1987). Quackgrass is now recognized to be the most serious perennial grassy weed of spring wheat in Manitoba (Thomas and Wise, 1984). Of the 4.4 million acres of wheat now grown in Manitoba, quackgrass occurs in 11% of the fields with a mean mid-season density of 10.4 shoots m^{-2} (Thomas and Donaghy, 1991).

Quackgrass is a long-lived perennial weed that spreads both by seed and an extensive underground rhizome system. In temperate climates around the world it is considered to be one of the three most serious weeds in 37 different crops (Holm *et al*,1977). Quackgrass is difficult to control culturally and although herbicides can provide effective short-term suppression, long-term control is inconsistent. It has been estimated that the lack of quackgrass control in Manitoba causes an annual total revenue loss of $21 million (Fox and Furtan, 1990). Not only does quackgrass result in direct yield loss it also is a major impediment to producers adopting soil conservation practices (Todd, 1987).

In response to the severity and importance of the quackgrass problem in Canada the

Canadian Expert Committee on Weeds established the National Quackgrass Action Committee in 1986. The objective of this committee was to focus research and extension activities towards developing a clearer understanding of the quackgrass problem so that a coordinated approach could be developed which would minimize the impact of this weed in Canada. The research outlined in this thesis was conducted as one step in the coordinated effort to achieve this objective.

Except for some investigations in Quebec (Leroux, 1990) and preliminary reports from this thesis (Wilcox and Morrison, 1988a, 1988b, 1989; Morrison *et al*, 1990; Wilcox, 1990) there is no published information on quackgrass interference in spring wheat in North America. To address this deficiency research was conducted to investigate the short-term and long-term implications of wheat-quackgrass interference.

Short-term implications were studied using both an experimental and survey approach. The experimental approach was used to investigate and model the relative importance of interspecific and intraspecific forces in wheat-quackgrass interference (Manuscript 1). As far as I am aware this is first report of a perennial species being studied in this kind of additive series design. The experimental approach was also used to elucidate and model some of the mechanisms responsible for wheat-quackgrass interference (Appendices 1, 3 and 4). The experimental approach was also used to study the growth of quackgrass plants from rhizome segments and seed in the absence of interference. The results of this research has been partially reported elsewhere (Wilcox and Morrison, 1987) and has not been included in this thesis.

A survey approach was used to model the relationship between quackgrass infestation

and wheat yield loss in commercial fields in Manitoba (Manuscript 2). To determine the most accurate measure of quackgrass interference in wheat a survey approach was also used to model the allometry between the various quackgrass parts (Manuscript 3). For both models the main survey approach used was an innovative dynamic stratified sampling design which has been adopted by other quackgrass researchers (Chikoye, 1990).

Long-term implications of quackgrass-wheat interference were studied by developing an integrated empirical spreadsheet model for instructional purposes (Manuscript 4). This spreadsheet model is useful for demonstrating the utility of a model for assisting in weed control decisions, even when based on limited data and using simple hardware and software.

A major theme in all this work has been to demonstrate the utility of new, or relatively recently developed, analytic techniques and models to explore the interference relationship between crops and weeds.