DEVELOPMENT OF WEED CONTROL TECHNOLOGY FOR CONSERVATION TILLAGE SYSTEMS

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Summary. This project will examine the effects of tillage practice, crop rotation and herbicide use in wheat in the Northern N.S.W. environment with the object of long-term reduction of weed populations.

INTRODUCTION

A survey of wheat crops in northern New South Wales during 1983 showed that the average level of wild oat infestation was 17,000 plants per hectare. The results of experiments at Tamworth show that this level would be sufficient to reduce wheat grain yield by 2% (32,300 tonnes). A grain value of $110 per tonne gives $3.6m as the loss in production due to wild oats alone in northern New South Wales. Assuming that yield reduction due to grass weeds was at a similar level in wheat crops throughout Australia, the total loss would be $44m. In addition, during 1983 an estimated $40m was spent on herbicides for grass control (in cereals) in Australia.

Lack of adequate weed control is one of the major factors preventing the adoption of Conservation Tillage practices by many wheat growers in Australia. Traditionally, weed populations are reduced in summer dominant rainfall areas in fallows by ploughing the stubble into the soil and cultivating to encourage emergence prior to sowing the crop. With the recent trend towards conservation tillage fallows, the weed seeds are retained at or near the soil surface. The survival rate of weed seeds under these conditions is unknown. The longevity of seeds which remain buried under conservation tillage fallows is also unknown. A further difficulty with conservation tillage fallows is that pre-emergence herbicides cannot be thoroughly incorporated, leading to a possible reduction in effectiveness. New herbicide formulations which might overcome this problem will be tested in this project.

The different microenvironments created by conservation tillage practices are likely to result in changes in the weed population. The changes will be influenced by the weed control spectrum of the herbicides used. There is also evidence that perennial weeds will become more prevalent if conservation tillage paractices are adopted. New strategies need to be developed to overcome these problems.

The objectives of this work are to survey and monitor the effects of conservation tillage practices and crop rotation on weed population dynamics, determine the effectiveness of currently recommended herbicides for control of weeds under new tillage practices and rotation sequences and carry out detailed germination and life history studies of weeds so that a simulation model of weed population dynamics can be compiled.

DEFINITION OF THE PROBLEM

Historically weeds have been controlled in wheat using crop rotation, fallow tillage operations, increased sowing rates and farm/machinery hygiene. With the advent of herbicides, however, growers have been encouraged to replace rather than complement these traditional methods with the use of herbicides. This practice, in combination with reduced seeding rates, is resulting in rapid build-up of weeds in continuous wheat cropping systems.

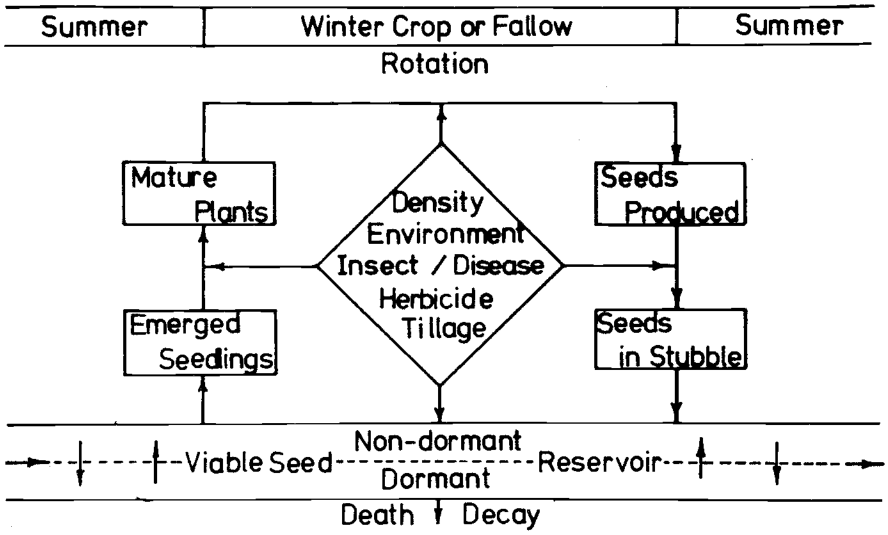
Although control of weeds using herbicides might give economic yield increases, they allow production of more than enough seeds to re-infest subsequent crops. The most efficient means of reducing weed seed numbers in the soil is by crop rotation (Philpotts, 1975). Inclusion of a summer crop in the rotation provides two winter fallows during which the seedlings that emerge can be prevented from seeding. The degree of control will depend on the conditions being favourable for germination of seeds.

Weed growth is often kept down by grazing between crops, usually in lucerne ley. However, grazing does not always prevent production of weed seeds, particularly during periods of feed surplus.

No research has been done on the effect of tillage and grazing practices on the fate of weed seeds retained in the stubble at harvest time. The number of seeds lost or consumed by birds under these conditions may also be of importance. The fate of seeds already buried beneath conservation tillage fallows is unknown. These seeds may remain largely undisturbed and could survive in a dormant state for indefinite periods.

Changes in tillage practice can bring about rapid changes in weed seedling populations, and these are to be monitored on No-tillage regional sites.

Fig. 1. Life cycle of a winter crop weed with seed dormancy.



INTEGRATION OF WEED CONTROL STRATEGIES

The farmer needs to be able to integrate weed control strategies so that levels of weed seeds in the soil can be progressively reduced. A schematic life cycle (Fig. 1) shows how management and environmental factors interact with the life sycle of a weed.

A farmer can use weed population dynamics information to determine the potential success of a particular weed control strategy, such as use of a post-emergence herbicide. The relationship between the number of wild oat plants (OP) and wheat grain yield (WGY) is hyperbolic (Fig. 2).

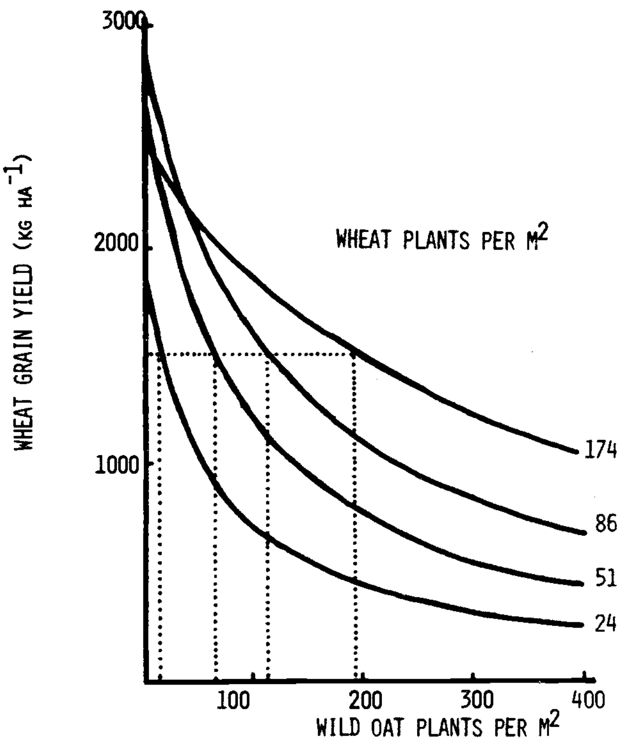


Fig. 2. Effect of wild oat competition on wheat grain yield at 4 crop densities

The effect of an individual wild oat plant on WGY is greater at low crop and weed density. The maximum effect of wild oats on WGY occurs at around 300-400 plants per square metre. Tamworth data was used to simulate the effect of using a post-emergence herbicide on a population of 50 wild oat plants per square metre at two crop densities assuming 70 and 90 percent control (Table 1).

Table 1. Simulated effect of post-emergence herbicide on crop yield.

	Wild oat plants m^{-2}	Wheat grain yield (kg ha^{-1}) 50 Wheat plants m^{-2}	80 Wheat plants m^{-2}
Nil herbicide	50	1660	2060
70 percent control	15	2250 ($60)*	2550 ($55)
90 percent control	5	2500 ($92)	2740 ($73)
No wild oats	0	2650	2850

* Value of increased yield @ $110 per tonne.

In this example the herbicide provided economic yield increases with 70 and 90 percent control of the wild oats. However, these treatments failed to kill 15 and 5 wild oat plants per m^2 respectively. The seeds (OS) produced from these populations can be estimated (McNamara pers. comm.). For a crop of 80 wheat plants per m^2 around 1000 and 350 seeds per m^2 would be produced for 15 and 5 wild oat plants respectively.

Assuming 50 percent mortality during the fallow and 30 percent emergence, the population of wild oats in a subsequent crop would be 50 and 150 plants per m^2 for 90 and 70 percent control respectively in the previous crop. More than 90 percent control of wild oats would be required for any long-term reduction in the seed population. Data collected from 1983 experiments indicate that > 95 percent control may be needed for long-term reduction of seed reserves. Mortality of weed seeds will vary according to environmental conditions, and therefore there is a need for this information to be collected at several localities in wheat growing areas.

PROPOSED RESEARCH PROGRAMME

A survey of farm management practices in relation to long-term weed control is to be continued. Information will be collected on: current farm enterprises, crop rotation, tillage practice, fertiliser use, crop density, grain yield and weeds (species, density and methods of control). Field experiments will be done to examine integration of management strategies for control of weeds (initially wild oats). Germination and dormancy studies are planned for weed seeds stored in the field under different crop, tillage and herbicide regimes. The species which should be studied include:

Wild oats *(Avena fatua, A. ludoviciana)*
Black bindweed *(Polygonum convolvulus)*
Wild radish *(Raphanus raphanistrum)*
Wireweed *(Polygonum aviculare)*
Wild phalaris *(Phalaris paradoxa)*
Variegated thistle *(silybum marianum)*
Saffron thistle *(Carthamus lanatus)*
Mexican poppy *(Argemone mexicana)*
Indian hedge mustard *(Sisymbrium orientale)*
Deadnettle *(Lamium amplexicaule)*
Wimmera ryegrass *(Lolium rigidum)*
Barley grass *(Hordeum leporinum)*
Brome grass *(Bromus spp.)*
Turnip weed *(Rapistrum rugosum)*

LITERATURE CITED

Philpotts, H. 1975. Weed Res. 15: 221-225.