SEED BANK DYNAMICS OF WILD OAT (*AVENA FATUA* L.) POPULATIONS IN WHEAT

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Summary. The dynamics of seed populations of wild oats (*Avena fatua* L.) in soils prepared using direct drill, shallow and deep inversion tillage practices were measured over three years in field plots sown to wheat. These were compared with changes in monospecific populations of wild oats grown on undisturbed soil. Substantial annual increases and decreases occurred in seed banks irrespective of soil disturbance treatments. Increases tended to be greatest under deep tillage whereas population decreases and the annual decline in seed banks were lower under treatments involving no or minimal soil disturbance. These changes were due far more to inputs of new seed than to the effects of seed carryover. It is concluded that research into improving long term control of wild oats would do better to concentrate on reducing seed inputs as opposed to reducing seed bank carryover.

INTRODUCTION

Wild oat species are important and persistent weeds of winter cereal cropping throughout the world. In Australia, a recent survey of farmers interviewed by Hoechst Aust. Ltd. found that wild oats occur on two out of three farms throughout the wheat belt, are increasing on more than 40% of the infested farms and the managers of over a third of these farms find them difficult weeds to control (Howat pers. comm., 1989). Medd and Pandey (5) estimated wild oats cost the wheat industry $41.35 million during 1987, indicating the importance of these weeds in Australia. Furthermore, wild oats, in common with many other annual grass weeds, are capable of proliferating under conservation tillage systems (3,6).

The mechanisms which allow wild oats to persist and to increase under certain management practices are, however, unclear. Some reports suggest that seed dormancy is the key factor, enabling large stocks of viable seed to be carried over from year to year (1,2). Other work has shown that seed banks of wild oats could be depleted within four years, regardless of the type of tillage practiced (7,8), indicative that factors other than seed longevity are involved.

This report examines the processes regulating seed bank populations, based on findings of demographic studies of one species of wild oats grown with wheat in the field under a range of tillage practices.

METHODS

In January 1983 a field site free of wild oats at the Research Centre, Orange was treated with 2 L/ha glyphosate and disc ploughed 6 weeks later prior to preparing a fine seedbed. Seed of *A. fatua* harvested from a single local population in December 1982 was sown over the site in June 1983 at 1560 seeds/m along with wheat (cv. Banks) at 200 seeds/m and the application of 200 kg/ha molybdenum superphosphate, 100 kg/ha potassium chloride, 4kg/ha each of zinc sulphate, copper sulphate, borax and 120 kg/ha ammonium nitrate. Wheat sowing rate and fertilizer applications remained identical during three subsequent annual crops. Plots were sown with a 15 run Bamlett Begg direct drill combine to which conventional tynes were fitted when sowing the tilled treatments.

Between 1984 and 1988, plots were assigned to three tillage treatments and an uncultivated monospecific weed treatment in a randomised split plot design having three replications. Main plot tillage treatments consisted of: soil inversion to a depth of 20 to 25 cm using a mouldboard plough for primary tillage followed by tyne or offset disc secondary tillage of the surface 5 to 10 cm (deep inversion); primary and secondary tillage of the surface 5 to 10 cm using tyne or offset disc implements (shallow tillage); direct sowing after control of vegetation in the fallow using 1.5 L/ha glyphosate and 0.7 L/ha dicamba (direct drill); and weed monoculture (undisturbed). Sub plots, each 2.1 by 10 m, were either treated or not with 2 L/ha of diclofop-methyl applied post-emergence. In the final year of experimentation, assigned plots received a second application of diclofop-methyl three weeks after the first.

Herbicides were applied using a carbon dioxide pressurized boom spray, mounted on the front of a tractor modified with wheel extensions to eliminate problems of damage or disturbance to plots. The same tractor was used for soil sampling thirty, 7.5 cm dia. cores taken to a depth of 12 cm from each sub plot after crop sowing, crop anthesis and harvesting. Cores, taken with the aid of hydraulic rams mounted at the rear of the tractor, were bulked according to treatment and air dried. Seed extraction used a system of wet sieving, flotation using calcium chloride (specific gravity 1.36) and winnowing prior to assessing apparent viability and counting (4). Only data for the sub plots treated with diclofop-methyl are presented.

RESULTS AND DISCUSSION

Wild oats showed a strong propensity to increase under all the cultural conditions examined, which reinforces the stated problem of its ability to persist under modern farming systems. After the initial three years of cropping, seed populations of wild oats had increased approx. four fold in the undisturbed monoculture and under shallow tillage, five fold under direct drilling and by six fold under deep inversion tillage (Fig.1). In the final year, double spraying with herbicide completely counteracted increases over the previous three years under shallow and deep inversion tillage whereas populations in the monoculture and direct drill treatments declined only to a level three fold of their commencement values.

However, during each year marked declines occurred in seed populations in all treatments (Table 1). This was assessed through the difference between values measured after harvest (maximum seed bank) and those taken at flowering in the subsequent crop (minimum seed bank). The decline was consistently >90% under deep inversion, >80% in shallow tillage and variable between years (71 to 92%) in the direct drill and monoculture treatments, being consistently lower during the final two years.

Since the measure of the seed bank at crop anthesis indicates the amount of seed remaining after recruitment and other losses due to tillage have been accounted for in that year, the value represents the maximum possible number of seeds that may be carried forward. In the initial years when populations increased (Fig. 1), the proportion of carryover seed contributing to the increase was low, mostly <10% and did not differ

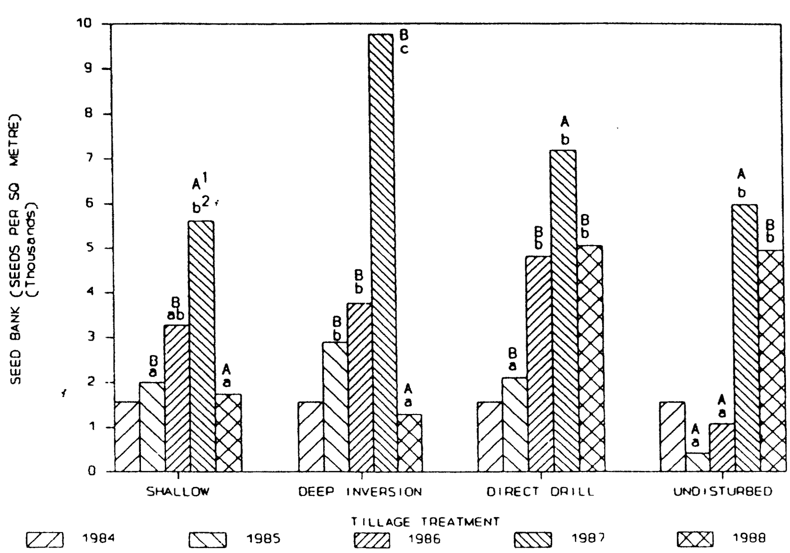

Figure 1. Annual changes in the maximal seed bank of wild oats between 1984 and 1988 under four tillage treatments (see footnote after table two).

Table 1. Annual decline in seed banks of wild oats (% seed bank at harvest time minus seed bank at next flowering/seed bank at harvest) under four tillage treatments over three years.

Treatment	1985	1986	1987
Shallow tillage	85.0 A[1]a[2]	86.7 AB a	83.1 B a
Deep inversion	92.4 A a	90.0 B a	91.7 C a
Direct drill	91.8 A b	72.5 A a	70.7 A a
Undisturbed	90.4 A b	77.5 A a	79.1 AB a

Table 2. Maximum annual proportion of seed available for carryover (% seed bank at flowering/seed bank at following harvest) under four tillage treatments over three crop cycles.

Treatment	1985-86	1986-87	1987-88
Shallow tillage	9.2 A[1]a[2]	7.9 A a	60.6 B b
Deep inversion	6.2 A a	3.9 A a	63.7 B b
Direct drill	3.6 A a	17.6 A a	42.9 A b
Undisturbed	7.1 A ab	6.1 A a	22.5 A b

Differences between means (p=0.05) in Figure 1, Tables 1 & 2 are shown as follows:

[1] Upper case letters indicate differences between treatments within years.

[2] Lower case letters indicate differences between years within treatments.

between treatments in the first two cycles (Table 2). However, the proportion of carryover seeds increased significantly during the final season, and was greater in deep and shallow tillage than in the direct drill or undisturbed treatments. Since the decline in seed populations did not alter over the final two years (Table 1) these increases must have been due to changes in the input of new seed, not to alterations in seed longevity.

With an annual rate of decline of 70% or greater, it could be shown that few seeds from the original infestation would remain in the seed bank after four years, provided no inputs of new seed occurred. It can thus be concluded that the input of new seed, not the carryover of seeds, was responsible for the marked fluxes in populations. In addition, since the annual decline rate is so high (>70%), it can be further concluded that the population of wild oats studied exhibited little long term seed dormancy.

As a consequence, developing ways of reducing seed carryover, such as by manipulating seed dormancy, would seem inappropriate except under circumstances where carryover seed stocks far exceed inputs of new seed. In the case of wild oats, reducing the input of new seeds offers a better immediate alternative for improving long term control in Australia - presuming other populations have similiar seed dormancy behaviour to that apparent in this study.

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