EFFECT OF TIME OF EMERGENCE ON REPRODUCTIVE BIOLOGY OF AUSTRALIAN POPULATIONS OF WILD OAT (*AVENA FATUA*)

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Summary. Wild oat (*A. fatua*) plants emerging earlier in the season had a longer life span though all plants set seed in a short period during October and November. Plants emerging earlier also were larger in stature producing more tillers, shoot dry matter and seeds which had low levels of dormancy. Plant growth and reproductive output of some lines was correlated closely with the photoperiod regime during plant growth. Some polymorphism was shown between the lines used in this study in both plant biology characteristics and their overall response to different emergence dates.

INTRODUCTION

The main persistence mechanism for wild oats (*Avena fatua*) is its ability to produce copious numbers of dormant seeds which germinate irregularly from the soil seed bank over the course of the season (5). Earlier growth cabinet studies have determined that *A. fatua* when exposed to varying environmental conditions such as photoperiod, temperature and water stress show marked differences in phenology, plant morphology and seed characters. For example *A. fatua* are long day (LD) plants with LDs hastening flowering and resulting seeds with low levels of dormancy (6). Most earlier studies have looked at these environmental effects under constant conditions in controlled growth cabinets. These studies are not always appropriate for analysing developments in the natural environment as they not take into account that the photoperiod is constantly changing and that plants react differently in pots than in swards. To overcome these concerns studies have been carried out to assess the effect of varying photoperiods by planting at different sowing dates (7) but these previous studies have not taken into account the genetic variability that is known to exist within the population (3,1). It is therefore more appropriate to study these effects using isogenic lines rather that heterozygous field populations.

The aim of this study is to determine if changing environmental regimes, as a result of different times of emergence in the field, has any effect on the seed production, dormancy and viability of *A. fatua*. To help understand any changes that may occur in these characters other morphological characters (*viz.* phenology, tiller and shoot biomass production) were recorded. Near isogenic lines chosen for study were from a small geographic location and this was expected to show the extent of polymorphism that may exist for environmental response within the study area.

METHODS

The field trial was carried out at Hermitage Research Station, near Warwick Queensland between April and December 1991. Six near isogenic lines from southern QLD and northern NSW were sown at 5 different times over the course of the season. The experimental design was a split plot design replicated in blocks comprising the 5 emergence dates as main plots, and isogenic lines as subplots. Each planting (2x14 m) comprised 6x1 m^2 subplots. Seed was pregerminated and hand planted in each plot at a density of 40 seeds/m^2 and grown to seed maturity. Measurements were made on phenology (time to floral initiation, anthesis and seed maturation), on plant morphology; fertile and total tiller and shoot production, and on reproductive biology;

an estimate of primary seed production (by measuring flower production due to the difficulty in collecting all dehisced seed), weight, dormancy and viability. Primary seed dormancy was assessed by imbibing caryopses in water and several concentrations of gibberellic acid (GA_3), a germination stimulant, for 20 days dark incubation at 20°C. A Pearson' Correlation Analysis was made comparing plant biology characteristics with cumulated photoperiod, a summation of the daily photoperiod (h) experienced during plant growth.

RESULTS AND DISCUSSION

Only results from two of the isogenic lines used in this study will be discussed in the scope of this paper. Trends shown by these lines are representative of all lines used in the initial study.

Plant Characters. Plants emerging early in the season were exposed to shortening days of autumn compared to those emerging later in the warming and lengthening days of spring. Early emerging plants had a longer life span but all plants regardless of emergence date flowered and set seed in a short period from mid October to mid November (Fig 1a). This would indicate a LD response with flowering hastened by lengthening days and supports earlier growth cabinet studies (6) and field studies (7). There was little polymorphism in duration of life span but some variation in response to different emergence dates amongst the lines studied. Plants emerging earlier is the season, and exposed to shorter days were found to produce more tillers (Fig 1b) which supports earlier field studies (7) but is in contrast to earlier growth cabinet studies (2). These plants also produced greater shoot production compared to later emerging plants (Fig 1c) with some polymorphism between the different lines studied.

Seed Characters. Those plants emerging earlier possessed a greater flower and seed production (Fig 1d) as these plants grew best under those conditions, producing the greatest tiller and shoot production. These results supports earlier studies (7). There was also some degree of polymorphism in the seed production between lines studied. Interestingly, little difference was found in the seed weight produced by plants emerging at different times (Fig 1e). This observation is in contrast to earlier growth cabinet studies, which showed that under conditions which result in a long life span small seeds are produced (1). Variations in seed size may be important in the persistence of *A. fatua* as seed size has previously been linked to longevity with small seeds less prone to predation and fungal attack in the soil seed bank (5) but this may not be the case in this instance. Differences were also found in the level of seed dormancy amongst the lines used in this study. Seeds produced by plants emerging in July were more dormant than other seeds (Table 1), though showed no difference in viability. Previous studies have suggested that plants with a short life span produce less dormant seeds (1) but this was not the case in this study.

Implications. The ultimate success *A. fatua* is due to its ability to produce large numbers of dormant viable seeds. This process is dependent on conditions experienced by the parent plant which has a bearing on initial plant growth and reproductive output. Some lines showed a correlation between plant biology and photoperiod exposure (Table 2). Plants emerging earlier with a longer cumulative photoperiod were larger in stature, produced more tillers and shoot dry matter and more seed with a low degree of seed dormancy. This may indicate how varying photoperiod regimes can determine the persistence of *A. fatua*. Irregular emergence of seeds from the soil seed from the bank results in plants being produced which are of different age and morphology and have been exposed to varying photoperiod regimes. These plants produce seed over a short peri/d and show phenotypic polymorphism in both numbers produced and dormancy

characters. Regardless of emergence date, some seed is produced that is capable of emerging irregularly from the seed bank. There was both some polymorphism in plant biology characters and the overall response to different emergence dates in the lines studied.

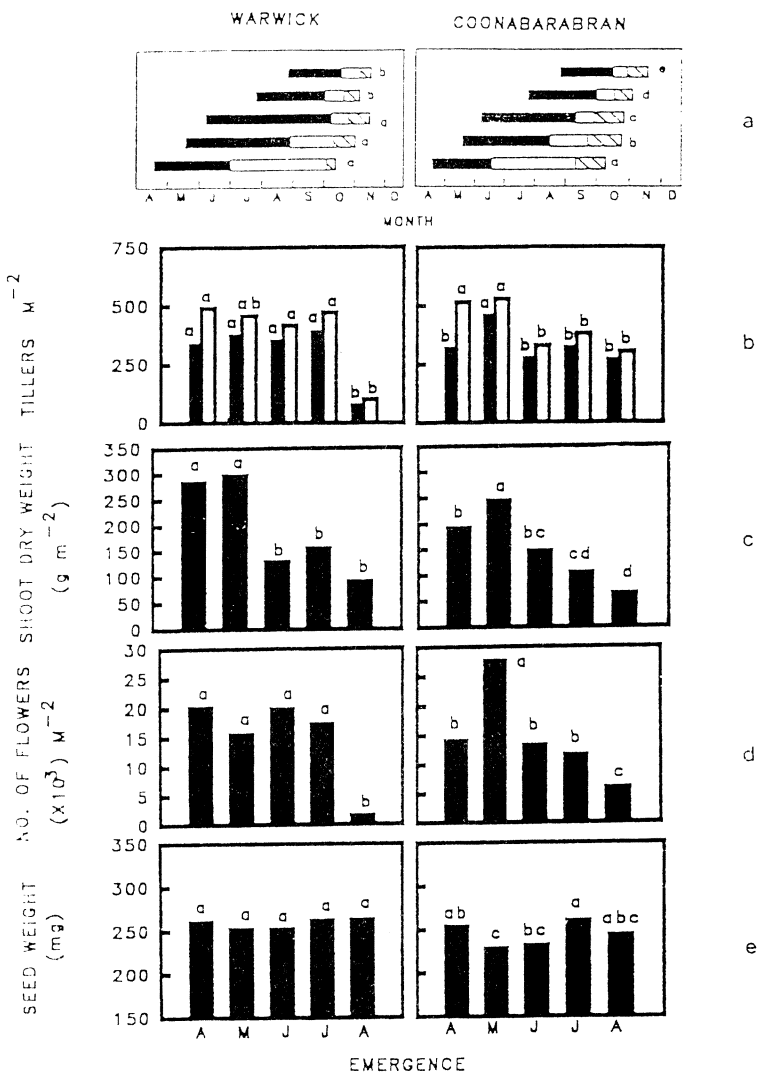

Figure 1. The influence of different emergence dates on the (a) phenology ; vegetative phase (■), reproductive phase (□), and maturation phase (□) (b) fertile (■) and total tiller (□) production (c) shoot dry weight, (d) seed production (flower production) and (e) seed weight of 2 near isogenic lines of *Avena fatua*. Values with the same letter are not significantly different (5% level) in each line.

Table 1. The influence of different emergence dates on the depth of seed dormancy (Germination % in 500 µM GA_3) of 2 near isogenic lines of *Avena fatua*. Values with the same letter are not significantly different (5% level) for each line.

Line	Emergence date				
	April	May	June	July	August
Warwick	95 a	68 ab	93 ab	30 b	73 ab
Coonabarabran	98 ab	98 ab	100 a	35 c	85 a

Table 2. Correlation of plant biology characteristics of 2 near isogenic lines of *Avena fatua* with cumulated photoperiod experienced during plant growth, using Pearson's Correlation Analysis. Coefficients are statistically significant at 5% (*), and 1% (**).

Characters	Pearson's correlations (vs. cumulated photoperiod)	
	Warwick	Coonabarabran
Total life span	0.97**	0.99**
Fertile tillers	0.01	0.28
Total tillers	0.56**	0.60*
Shoot production	0.78**	0.65**
Seed production	0.72**	0.51
Seed weight	0.43	-0.14
Seed dormancy	0.25	0.80*

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