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Differential responses of tillers to floral induction in
perennial ryegrass (*Lolium perenne* L.):
implications for perenniality.

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ABSTRACT

Development of sustainable practices is an important goal in agriculture. One possibility involves the development of perennial cereal crops, but the mechanisms of perenniality first need to be understood. While in annual cereals flowering structures die following seed production, in perennial grasses, perenniality is achieved by maintaining at least one shoot in a vegetative state.

There are two views on perennating tiller origin in perennial grasses: some authors suggest that all over-wintering tillers flower in spring and summer, leaving spring-initiated tillers to perennate, while others indicate that spring-initiated tillers are too immature to survive summer conditions, thereby implying that flowering must be prevented in some over-wintering tillers. An understanding of perenniality will therefore require an understanding of flowering control in these species. Temperate perennial grasses have dual induction requirements for flowering, where plants become competent to perceive inductive signals following vernalisation, and flowering is initiated by inductive photoperiods. Two hypotheses were formulated to test these models. The 'environmental control hypothesis' stated that all adequately vernalised perennial ryegrass tillers would flower on sufficient exposure to inductive photoperiods. Alternatively, the 'spatial control hypothesis' stated that in addition to the environmental mechanisms, a spatial control mechanism acts to regulate flowering. Two experiments were conducted to test these hypotheses.

Perennial ryegrass and Italian (annual) ryegrass were induced to flower and differences between the annual and perennial habits at flowering time were observed. However neither hypothesis was proven. In the second experiment, flowering was studied in detail in individual tillers of perennial ryegrass. The eldest tiller flowered in all flowering plants. The second eldest tiller did not flower in 72% of plants with more than one reproductive tiller, while the third eldest tiller flowered in 94% of these plants. These data favour the spatial control hypothesis which suggests that a spatial regulatory mechanism might act to repress flowering in some competent perennial ryegrass tillers. These results were supported by studies of meristem morphology and by a preliminary gene expression study. Maintenance of older, established tillers in a vegetative state might allow the perennial plant a greater chance of survival during summer.

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MATTHEW: Aunty Mush is going to be famous. She's writing a book.

MATTHEW'S GRANDMA: Do you know what the book is about?

MATTHEW: No.

MATTHEW'S GRANDMA: Grass. How many people are going to want to read that?

MATTHEW: Oh. (Somewhat disappointed)

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ABBREVIATIONS

<i>API</i>	<i>APETALA 1</i>
<i>CO</i>	<i>CONSTANS</i>
<i>FLC</i>	<i>FLOWERING LOCUS C</i>
<i>FT</i>	<i>FLOWERING LOCUS T</i>
LD	long day
<i>LpFT3</i>	<i>Lolium perenne FLOWERING LOCUS T 3</i>
<i>LpGAPDH</i>	<i>Lolium perenne GLYCERALDEHYDE-3-PHOSPHATE DEHYDROGENASE</i>
<i>LpMADS3</i>	<i>Lolium perenne MADS 3</i>
NISD	non-inductive short day
PCR	Polymerase chain reaction
PPF	photosynthetic photon flux
PRC2	Polycomb group Repressor Complex 2
RT-PCR	Reverse transcription-polymerase chain reaction
SD	short day
<i>SOC1</i>	<i>SUPPRESSOR OF OVEREXPRESSION OF CONSTANS 1</i>
<i>VIN3</i>	<i>VERNALIZATION INSENSITIVE 3</i>
<i>VRN1</i>	<i>VERNALIZATION 1</i>
<i>VRN2</i>	<i>VERNALIZATION 2</i>
<i>VRN3</i>	<i>VERNALIZATION 3</i>