Genetic and Photoperiodic Control of Soybean Reproductive Phase

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INTRODUCTION

The duration of the reproductive phase is critical to soybean yield. Understanding the mechanisms that control this phase can help tailor soybean cultivars to their environment and thus improve yield.

What factors control the duration of the reproductive phase; genetics, photoperiod or both?

The E-gene series of loci in soybean have been reported to control both flowering and maturity through a photoperiod-mediated response. Is it possible that these genes control the duration of the reproductive phase of development?

OBJECTIVE

The objective of the current study was to determine the role of photoperiod and E-genes on the duration of the reproductive phase in soybean.

METHODOLOGY

Fig. 1. Field plots of the incandescent long day experiment at Spindletop research farm, Spring 2004. Black plastic was draped over the PVC frames to exclude incandescent light from other treatments.

Table 1. Genotypes of the E-gene NILs grown in 2003 and 2004 of the planting date experiment and in 2004 of the day length extension experiment. ("e" represents recessive alleles while "E" represents dominant alleles).

Clark Isolines	Harosoy Isolines	Alleles at locus E1	E2	E3	E4	E5	E7	# of dominant alleles*	Experiment(s) in which tested
-	OT94-47	e1	e2	e3	e4	e5	e7	0	Both
L92-21	OT89-5	e1	e2	e3	e4	e5	E7	1	Planting Date
L71-920	L62-667	e1	e2	e3	E4	e5	E7	2	Both
-	OT93-26	E1	e2	e3	e4	e5	E7	2	Planting Date
-	OT93-28	E1	e2	e3	e4	e5	E7	2	Planting Date
L63-3117	Harosoy	e1	e2	E3	E4	e5	E7	3	Planting Date
L63-2404	L84-307	e1	E2	e3	E4	e5	E7	3	Planting Date
L80-5914	L71-802	E1	e2	e3	E4	e5	E7	3	Both
L66-432	L67-2324	E1	e2	E3	E4	e5	E7	4	Both

* The E1 allele counted as 2 dominant alleles

Experiments were conducted in 2003 and 2004. The E-genes near-isogenic lines (NILs) were tested in two genetic backgrounds (Table 1).

Exp. 1: Incandescent Long Day test: Seven E-gene NILs were planted to synchronize flowering (using gene based flowering model of Stewart et al., 2003). The main plots were two photoperiod treatments imposed post flowering; i) ambient day length, and ii) an ambient plus three hour incandescent day length extension (Fig. 1).

Exp. 2: Planting date experiment: Main plots were two planting dates (Late May and Early June in 2003 and 2004, and split plots were 15 E-gene NILs.

Growth stage and temperature data were collected. Growing degree days and average photoperiod were calculated for duration to R1, R7 and the period between R1 and R7.

RESULTS & DISCUSSION

E-genes and time to flowering and maturity

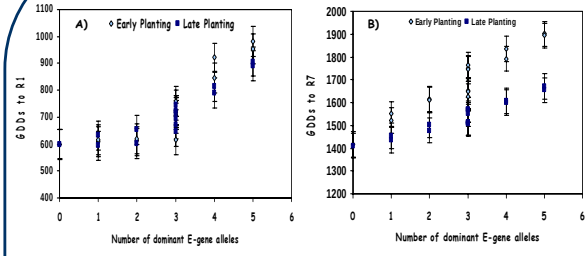


Fig. 2. Impact of planting date and the number of dominant E-gene alleles on A) GDDs to R1, and B) the GDDs to (R7). The early planting treatment generally received a longer average photoperiod than the late planting treatment.

Time to flowering (R1) and maturity (R7) increased with the number of dominant alleles. Time to R7 was more affected by planting date than R1, especially in those NILs with 3 or more dominant E-gene alleles (Fig. 2).

E-genes and reproductive duration

When grown under identical post-flowering photoperiod and temperature (Exp.1), genotypes with higher number of dominant E-gene alleles had longer reproductive phase (Fig.3).

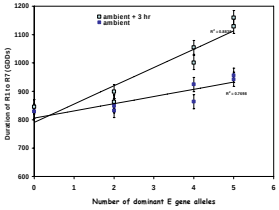
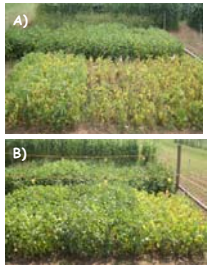


Fig. 3. Impact of the number of dominant E-gene alleles on the duration of the reproductive phase (R1-R7), under ambient and extended photoperiod conditions (amb+3hr).



Field photograph of Exp. 2. The 7 NILs grown under A) amb, and B) amb+3hr treatments. Photograph taken on August 31, 2004.

Photoperiod and reproductive duration

Photoperiod extension, either artificially (Exp. 1)(Fig. 3) or by early planting (Exp. 2)(Fig. 4), significantly increased the duration of the reproductive phase in NILs with dominant alleles (at one or more of the E-gene loci).

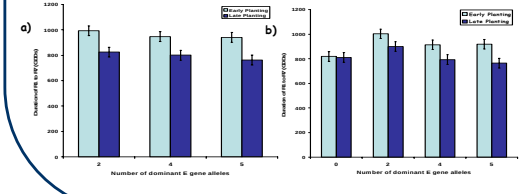


Fig. 4. Impact of the number of dominant E-gene alleles from a) 'Clark' and b) 'Harosoy' backgrounds on the duration of the reproductive phase (R1-R7), under early and late planting (longer and shorter average photoperiod experienced during reproductive development, respectively). Bars represent standard error of the difference between means

CONCLUSION

E-genes impact the duration of the soybean reproductive phase. Dominant E-gene alleles extend the duration of the reproductive phase in a photoperiod-mediated response.