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GENETIC ANALYSIS OF GROWTH OF DETERMINATE SOYBEAN GENOTYPES UNDER THREE PHOTOPERIODS

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ABSTRACT

Soybean is a short day plant highly influenced by photoperiod. Response to day length is determined by the genotype, and the genetic control of flowering and growth is distinct and independent for long and short day conditions. In this work four parents, including three with a classical type of response to photoperiod (BR85-29009, FT-2 and BR-13) and one long juvenile trait carrier (OC-8), were crossed in all combinations to obtain six sets of F2 and F3 generations. The parental response to final plant height, days to flowering, trifoliolate leaf number and average length of the internode and the genetic mechanisms controlling photoperiodic response of these traits in the six crosses were studied. Variation in day length was obtained by sowing in September, October and November at Londrina (23° and 22' of latitude). Results showed that additive genetic effects predominated in the control of all traits. For adequate progress, selection for plant adaptation must be done for days to flowering and/or final plant height at each sowing. There is probably a single genetic mechanism, involving several loci, controlling days to flowering in the three photoperiods in soybeans.

INTRODUCTION

Soybean is a short day plant highly influenced by photoperiod. The influence of day length on the development of the soybean plants depends on the genotype (Hartwig, 1973). Obtaining adequate plant development is the main problem to tackle in breeding soybeans for sub-tropical and tropical conditions. In Brazil, nearly all cultivated soybeans are of determinate growth habit, and most of the adaptation problems have been solved using these genotypes (Toledo *et al.*, in press). According to several authors,

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Gregan and Hartwig (1984), Hinson (1989), Kiihl and Garcia (1989), there are two main distinct groups of determinate soybeans genotypes adapted for cultivation in latitudes of 23° or less: a) those classical types that reach harvestable plant height because they have adequate critical day length to delay flower induction under short day conditions; b) those that have a long juvenile period and are insensitive to flower induction during a longer period after germination.

The adaptation of classical types to latitude changes in tropical regions is less critical than in temperate regions because comparatively wider latitude bands are required for similar day length changes. In addition, the long juvenile period further widens soybean adaptation to latitude and planting date changes. The mechanisms conditioning plant adaptation and their genetic control, however, are not completely known.

In this work, four soybean lines or cultivars, distinct in their response to day-length changes and representing both types of photoperiod responses were chosen as parents in a study designed to further explore and understand the adaptation mechanisms and the gene action controlling plant growth.

MATERIAL AND METHODS

The four parental lines or cultivars, BR85-29009 (União(6) x Lo76-1763, a selection of Industrial), FT-2 (selection in IAS-5), BR-13 (Bragg(4) x Santa Rosa) and OC-8 (late mutant of Paraná), mature between 120 and 135 days in early November plantings at Londrina (22°23' of Latitude S). They vary considerably, however, in their response to day length changes. Cultivar OC-8 has the long juvenile period trait (Bonato, 1989), while BR85-29009, FT-2 and BR-13 are classical soybean genotypes in their response to day length changes, although bearing distinct genetic architecture (EMBRAPA, 1992). The six possible combinations between these four parents, the F2 and F3 (family) generations, including reciprocals, were obtained. These combinations of crosses include the pairing of long juvenile with classical types and the pairing of genetically distinct classical types.

The diverse photoperiodic conditions were obtained by sowing the materials at three distinct dates: September 26, October 17 and November 16 in the experimental field at Londrina, using hill plots with individual plant randomization in a complete randomized design. All three field lay-outs were similar with differences due only to independent randomization. Field conditions were kept at optimum or nearly optimum for normal plant development and included supplementary irrigation.

Data scoring of the generations involved the following characters: final plant height, number of trifoliolate leaf nodes and days from germination to the opening of the first flower. The average length of the internode was obtained by dividing the final plant height by the number of nodes. Means and variances of each parent and their derived

generations were calculated. After verification for the presence of reciprocal effects the means were averaged and the variances pooled over reciprocals for further genetical analysis (Mather and Jinks, 1982). Genetic model fitting to means and variances was carried out by weighted least squares (Cavalli, 1952; Hayman, 1960; Mather and Jinks, 1982) using a personal computer program (Toledo, 1990). The genetic analysis followed the models proposed and discussed by Toledo *et al.* (1991). The estimated genetic effects were used to calculate the individual cross potential to generate superior inbred lines (Jinks and Pooni, 1976). Single plant heritabilities were calculated following the procedures presented by Mather and Jinks (1982). The genetic correlations between the traits were also obtained (Vencovsky and Barriga, 1992).

RESULTS AND DISCUSSION

Degrees of freedom, means and variances of the parents and the F2 and F3 generations of each cross and each date of sowing are presented in Tables I to IV, after averaging over reciprocals. Reciprocal effects were detected in six out of 72 opportunities (once for number of nodes, twice for days to flowering and three times for final plant height) but their magnitudes were always small and of no practical relevance.

Soybean sowing dates for Londrina normally extend from October 20 to December 15, with the period between November 5 and 15 being accepted as ideally suited for maximum development and yield (EMBRAPA, 1992). Compared to December, the earlier sowings involve plants submitted to shorter day lengths. In this work, antecipation of sowing from November 16 to October 17 and September 26 caused, as expected, differential response of parental types and their derived genotypes for final plant height, number of trifoliolate nodes, days to flowering and average length of internode.

In general, plant height was maximum for November, followed by the October and September sowings, respectively. Minimum plant height for full yield expression and harvesting is usually accepted to be 55 cm. Adequate height was only reached by all parents for the third sowing date. Line BR85-29009 and cultivar OC-8 also reached adequate height in October. FT-2 and BR-13 did not develop properly for the September or the October sowings. Cultivar OC-8 was the tallest parent in all sowing dates. Using the November results as a basis for comparison, it was noted that OC-8 reached 57.5% and 70.0% "normal" lenght for the September and October sowing dates, respectively. The breeding line BR85-29009 reached 48.6% and 75.0%, respectively. BR-13 reached 41.1% and 62.5%, respectively. FT-2 was the shortest cultivar in the first sowing, reaching only 34.2% of its November height. In the October sowing it reached 61.9%. Changes in the final height of the parental genotypes, due to photoperiod variation, were observed to result from changes in the number of nodes and in the length of the internodes. These responses also depended on the genotype. In cultivars FT-2 and BR-13, internode length

and node number were significantly affected by the plant response to photoperiodic change. In OC-8 and BR85-29009, changes occurred more due to an increase in the average length of the internodes than the node number, although significant differences were also detected for both components along the sowing dates.

The longest interval between germination and opening of the first flower was observed in the October sowing. The breeding line BR85-29009 was the last material to flower in October and November sowings, while OC-8 was the latest in September. Considering November as the basis for comparison, the percentual variation in days from germination to flowering in October and September was 107.0% and 110.1% for OC-8, 96.1% and 110.8% for BR85-29009, 85.5% and 102.7% for FT-2 and 84.6% and 97.4% para BR-13, respectively. The action of the long juvenile trait, delaying flowering in cultivar OC-8 was evident in the September sowing.

The genetic models adjusted to means and variances of final plant height, days to flowering, trifoliolate leaf nodes and internode length for each sowing date, are shown in Tables V to XII. They indicated that a wide range of effects is in control of the characteristics. Additive genetic effects predominated for all crosses and sowings. Dominance was also detected in several opportunities. Its direction and magnitude varied with the crosses and time of sowing. The relative magnitude of [d], [h] and D (Mather and Jinks, 1982) indicated that dispersion of genes in the parents was common for several characters and crosses. Complications such as epistasis, linkage disequilibrium and genotype x environment interaction were observed in fewer cases. They were more frequent, however, for the September and October sowing dates. Three times no satisfactory variance model was found, indicating the presence of complex gene action (interaction). In two cases no genetic variability was detected by either mean or variance analysis. No particular genetic model or effect could be associated with crosses in which the cultivar OC-8 (carrier of the long juvenile gene) was a parent. The genetic variability was smaller for number of trifoliolate leaf nodes and average length of the internodes than for final plant height and days from germination to flowering. The heritability values of plant height and days to flowering were higher than those for number of nodes or internode length (Table XIII). Heritability of plant height and days to flowering was higher for crosses having OC-8 as one of the parents, especially in the September and October sowings. The phenotypic correlations between plant height, number of days from germination to flowering, number of trifoliolate leaf nodes and internode length are presented in Table XIV. Given these heritability and correlation values, it is likely that selection for an increase in plant height directly or in days to flowering would produce similar results in terms of plant development in any of the photoperiods. The counting of trifoliolate leaf nodes could also be helpful, especially in the September and October sowings. The final decision would be made, by taking into consideration the labor and time necessary to perform selection for each trait. The results of selection for plants

scoring higher than OC-8 for final plant height, days to flowering, leaf nodes and internode length, for each sowing date, have been predicted and are presented in Table XV. The expected proportion of inbred lines scoring higher than OC-8 indicated that the selection efficiency is highly dependent on the cross and trait. They also indicated that generalizations concerning selection, based on heritabilities and correlations, can be helpful, but by no means assure high efficiency. Selection, clearly, would have to be performed for each sowing date. The performance of individual F3 genotypes, in one sowing date had little predictive value for the others. This fact was previously reported by Kiihl (1976).

The fact that selection for one sowing date does not necessarily imply plant adaptation in the others, may have led breeders to conclude that there were two genetic systems controlling days to flower in soybeans. Our results, however, indicate that there is a single genetic system controlling days from germination to flowering of soybean, regardless of the photoperiod. The parental analysis showed that the day length response to BR85-29009, a classical genotype, was not too different from that of OC-8. Also, the distributions of the F2 and F3 generations of the crosses (Tables XVI and XVII), even those including OC-8, were continuous or nearly continuous and almost always transgressive in all sowings. In addition, some individual F3 genotypes stemming from crosses between classical genotypes behaved as carriers of the long juvenile trait in the September and October sowings. For most crosses, it was possible to screen F3 genotypes that showed variable expression of the long juvenility trait in the September and October sowing and similar plant height and number of days to flower in the November sowing. In short, the data indicated that a clear cut differentiation between the two types of day length response, long juveniles and classical types, is not always easily established and that the genes controlling flowering in soybeans are, probably, not divided into two independent systems as previously reported (Kiihl, 1976; Hinson, 1989; Kiihl and Garcia, 1989), but are part of a single system controlled by many loci. These earlier works were, most likely, reporting studies on specific segments of the total existing variability. The genetic models fitted to all characteristics in all sowings showed similar genetic effects when OC-8 or the other parents were involved. This gave further indication that there is a single complex genetic system controlling the photoperiodic response in soybeans. The authors believe that breeding work, introducing major genes or using single gene mutations to adapt soybeans to the tropics, created the apparent distinction between the genetic mechanisms controlling plant height and flowering in long and short day conditions. As more and more adapted materials are developed, the initial discrete distribution of soybean genotypes, divided between carriers of the long juvenile trait and not carriers, is becoming continuous. Gaps of the discrete distribution are being filled with genotypes showing a whole range of intermediate reactions to photoperiod. This can only be obtained through recombination of different genes of a single system.

TABLE I. Means, variances and degrees of freedom of final plant height.

Genotype	26th September			17th October			16 th November		
	df	mean	var	df	mean	var	df	mean	var
BR 85-29009	23	35.79	24.46	22	55.22	56.27	25	73.58	42.41
FT-2	28	23.97	16.68	27	43.39	14.84	22	70.09	26.99
BR-13	27	25.75	10.63	20	39.10	35.99	27	62.57	30.25
OC-8	24	47.80	26.75	25	58.15	51.82	28	83.10	35.88
BR 85-29009 x FT-2									
F2	113	29.21	30.01	102	46.21	41.95	99	67.54	74.35
F3 Total	142	29.39	46.89	126	46.19	67.25	131	68.32	73.52
Between (families)	29		91.22	29		146.06	29		147.25
Within (families)	113		34.90	97		40.46	102		50.62
BR 85-29009 x BR-13									
F2	113	26.91	34.02	113	43.29	52.66	106	64.85	87.06
F3 Total	144	26.46	39.07	131	43.29	95.06	136	65.22	103.45
Between (families)	29		80.20	29		227.06	29		180.48
Within (families)	115		28.25	102		55.14	107		81.54
BR 85-29009 x OC-8									
F2	107	41.27	127.26	101	56.75	79.24	109	75.39	97.05
F3 Total	144	40.24	118.18	137	52.62	117.99	134	76.08	107.46
Between (families)	29		328.36	29		245.53	29		282.13
Within (families)	115		62.86	108		81.80	105		56.38
FT-2 x BR-13									
F2	115	26.35	22.41	104	41.89	51.05	92	68.59	64.56
F3 Total	146	28.78	45.38	133	42.54	90.01	131	68.33	69.71
Betwwen (families)	29		117.36	29		193.95	29		141.00
Within (families)	117		26.82	104		54.65	102		47.90
FT-2 x OC-8									
F2	112	32.01	29.70	104	48.98	59.38	103	77.56	81.53
F3 Total	139	32.08	42.92	134	51.26	52.03	128	78.03	88.79
Between (families)	29		108.98	29		96.63	29		188.23
Within (families)	110		24.54	105		39.00	99		57.91
BR-13 x OC-8									
F2	111	31.34	55.10	103	47.08	62.10	107	74.78	52.91
F3 Total	136	31.06	78.50	127	45.56	72.34	138	73.19	86.95
Between (families)	29		219.89	29		194.94	29		222.35
Within (families)	107		38.01	98		33.41	109		49.16

TABLE II. Means, variances and degrees of freedom of days from germination to flowering.

Genotype	26th September			17th October			16 th November		
	df	mean	var	df	mean	var	df	mean	var
BR 85-29009	26	46.41	10.89	26	53.48	3.72	25	48.27	1.00
FT-2	28	37.72	4.85	28	45.31	3.22	27	44.11	1.06
BR-13	26	34.19	0.85	23	39.38	2.85	28	40.41	0.97
OC-8	24	49.72	8.21	25	51.19	1.84	28	46.48	1.12
BR 85-29009 x FT-2									
F2	115	41.87	10.69	112	48.35	5.44	108	45.87	2.17
F3 Total	142	42.38	15.88	137	48.14	8.03	137	45.54	2.84
Between (families)	29		42.99	29		18.83	29		6.03
Within (families)	113		8.55	108		4.92	108		1.93
BR 85-29009 x BR-13									
F2	113	39.58	16.89	115	45.72	11.80	109	44.50	3.83
F3 Total	143	39.17	19.48	141	44.74	14.07	142	44.14	5.75
Between (families)	29		49.86	29		34.42	29		16.14
Within (families)	114		11.41	112		8.52	113		2.96
BR 85-29009 x OC-8									
F2	108	48.59	30.08	110	52.38	15.84	109	47.70	9.98
F3 Total	144	48.43	25.69	142	51.00	14.79	135	47.81	9.49
Between (families)	29		56.79	29		43.16	29		27.06
Within (families)	115		17.50	113		7.18	106		4.44
FT-2 x BR-13									
F2	115	35.98	5.47	109	43.08	5.58	110	42.92	3.91
F3 Total	148	37.50	27.16	139	42.95	17.31	141	42.90	5.47
Between (families)	29		87.87	29		59.71	29		18.30
Within (families)	119		11.83	110		5.42	112		1.99
FT-2 x OC-8									
F2	112	42.23	13.97	108	48.44	8.55	111	45.94	5.13
F3 Total	141	41.39	17.43	139	47.91	12.34	139	46.28	5.63
Between (families)	29		56.17	29		37.01	29		13.39
Within (families)	112		6.86	110		5.47	110		3.48
BR-13 x OC-8									
F2	112	40.41	22.20	106	46.23	15.49	108	44.36	7.29
F3 Total	137	39.61	31.27	138	45.94	25.95	143	43.88	8.01
Between (families)	29		107.48	29		64.35	29		27.58
Within (families)	108		9.64	109		15.10	114		2.81

TABLE III. Means, variances and degrees of freedom of number of trifoliolate leaf nodes.

Genotype	26th September			17th October			16 th November		
	df	mean	var	df	mean	var	df	mean	var
BR 85-29009	23	11.29	2.04	22	12.65	1.78	25	13.50	4.42
FT-2	28	8.41	1.61	27	11.75	1.53	22	12.52	3.08
BR-13	27	7.61	1.14	20	10.29	1.61	27	11.75	2.12
OC-8	24	13.56	2.42	25	12.85	1.82	28	13.93	1.42
BR 85-29009 x FT-2									
F2	111	9.84	2.11	102	12.46	1.68	99	12.80	2.46
F3 Total	142	9.86	3.03	125	12.28	2.66	131	12.67	2.46
Between (families)	29		6.96	29		4.35	29		3.43
Within (families)	113		1.97	96		2.07	102		2.15
BR 85-29009 x BR-13									
F2	112	9.12	2.63	112	12.08	2.37	106	12.70	2.43
F3 Total	144	8.94	2.47	131	11.66	3.47	136	12.49	2.59
Between (families)	29		4.05	29		6.38	29		3.13
Within (families)	115		2.05	102		2.59	107		2.44
BR 85-29009 x OC-8									
F2	107	12.32	6.35	101	13.49	1.95	109	13.91	2.87
F3 Total	144	12.08	6.12	137	12.98	2.57	134	13.53	2.82
Between (families)	29		13.87	29		2.89	29		5.92
Within (families)	115		4.08	108		2.48	105		1.91
FT-2 x BR-13									
F2	115	8.31	1.61	103	11.19	2.76	92	12.72	2.36
F3 Total	146	8.82	3.70	132	11.18	3.67	131	12.68	2.76
Between (families)	29		10.39	29		7.33	29		3.77
Within (families)	117		1.98	103		2.40	102		2.45
FT-2 x OC-8									
F2	112	10.24	2.28	104	12.47	2.16	103	13.24	2.63
F3 Total	139	10.09	2.56	134	13.08	2.24	128	13.73	3.58
Between (families)	29		6.72	29		3.37	29		5.81
Within (families)	110		1.41	105		1.91	99		2.89
BR-13 x OC-8									
F2	110	9.71	3.46	103	12.39	2.78	107	13.35	2.08
F3 Total	136	9.45	3.99	126	11.71	2.85	138	12.99	2.95
Between (families)	29		9.23	29		7.25	29		5.88
Within (families)	107		2.49	97		1.43	109		2.13

TABLE IV. Means, variances and degrees of freedom of average length of plant internodes.

Genotype	26th September			17th October			16 th November		
	df	mean	var	df	mean	var	df	mean	var
BR 85-29009	23	3.28	0.32	22	4.38	0.29	25	5.52	0.45
FT-2	28	2.86	0.14	27	3.72	0.16	22	5.70	0.71
BR-13	27	3.42	0.20	20	3.81	0.22	27	5.37	0.32
OC-8	24	3.55	0.20	25	4.56	0.42	28	5.99	0.22
BR 85-29009 x FT-2									
F2	111	2.98	0.20	102	3.73	0.26	99	5.31	0.45
F3 Total	142	3.00	0.33	125	3.78	0.27	131	5.43	0.45
Between (families)	29		0.66	29		0.40	29		0.68
Within (families)	113		0.24	96		0.22	102		0.38
BR 85-29009 x BR-13									
F2	112	2.96	0.25	112	3.59	0.22	106	5.16	0.68
F3 Total	144	2.96	0.26	131	3.71	0.32	136	5.27	0.67
Between (families)	29		0.36	29		0.52	29		1.15
Within (families)	115		0.23	102		0.26	107		0.54
BR 85-29009 x OC-8									
F2	107	3.32	0.23	101	4.22	0.34	109	5.47	0.62
F3 Total	144	3.32	0.25	137	4.07	0.53	134	5.67	0.55
Between (families)	29		0.48	29		1.22	29		1.15
Within (families)	115		0.19	108		0.34	105		0.37
FT-2 x BR-13									
F2	115	3.21	0.33	103	3.76	0.28	92	5.43	0.41
F3 Total	146	3.30	0.29	132	3.82	0.33	131	5.44	0.54
Betwwen (families)	29		0.54	29		0.44	29		0.65
Within (families)	117		0.23	103		0.29	102		0.51
FT-2 x OC-8									
F2	112	3.14	0.15	104	3.95	0.31	103	5.90	0.48
F3 Total	139	3.19	0.19	134	3.95	0.34	128	5.74	0.49
Between (families)	29		0.27	29		0.44	29		0.44
Within (families)	110		0.16	105		0.31	99		0.50
BR-13 x OC-8									
F2	110	3.23	0.20	103	3.82	0.35	107	5.64	0.42
F3 Total	136	3.27	0.21	126	3.91	0.36	138	5.69	0.57
Between (families)	29		0.38	29		0.61	29		0.78
Within (families)	107		0.16	97		0.28	109		0.51

TABLE V. Genetic parameters adjusted to the means of final plant height.

	BR 85-29009 x FT-2	BR 85-29009 x BR-13	BR 85-29009 x OC-8	FT-2 x BR-13	FT-2 x OC-8	BR-13 x OC-8
			(i) First Sowing Date			
m	29.45 ± 0.33	26.67 ± 0.37	41.20 ± 0.50	25.04 ± 0.48	32.03 ± 0.38	31.21 ± 0.51
[d]	5.79 ± 0.61	5.02 ± 0.59	5.99 ± 0.72	-	11.91 ± 0.64	11.02 ± 0.60
[h]	-	-	-	27.29 ± 5.36	-	-
[i]	-	4.09 ± 0.70	-	-	3.86 ± 0.74	5.56 ± 0.79
[j]	-	-	-	-	-	-
[l]	-	-	-	-49.34 ± 10.30	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	0.69	0.36	1.81	3.32	0.0028	0.07
df	2	1	2	1	1	1

(ii) Second Sowing Date

m	48.59 ± 0.76	46.24 ± 0.89	56.83 ± 1.05	41.89 ± 0.43	50.46 ± 0.41	46.30 ± 0.54
[d]	5.46 ± 0.82	7.90 ± 1.02	-	1.80 ± 0.67	7.20 ± 0.69	9.52 ± 0.96
[h]	-5.54 ± 2.11	-6.72 ± 2.39	-33.55 ± 9.87	-	-	-
[i]	-	-	-	-	-	2.33 ± 1.10
[j]	-	-	-	-	-	-
[l]	-	-	66.76 ± 18.41	-	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	3.01	3.42	1.93	1.54	5.57	2.03
df	1	1	1	2	2	1

(iii) Third Sowing Date

m	71.33 ± 0.75	67.73 ± 0.76	78.13 ± 0.78	66.59 ± 0.68	76.34 ± 0.48	72.63 ± 0.70
[d]	1.66 ± 0.83	5.43 ± 0.82	4.79 ± 0.85	3.77 ± 0.75	6.50 ± 0.78	10.25 ± 0.76
[h]	-8.67 ± 2.38	-6.91 ± 2.41	-6.36 ± 2.53	4.79 ± 2.19	-	4.05 ± 2.04
[i]	-	-	-	-	-	-
[j]	-	-	-	-	-	-
[l]	-	-	-	-	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	1.89	1.18	0.41	0.72	3.57	0.43
df	1	1	1	1	2	1

TABLE VI. Genetic parameters adjusted to the variances of final plant height.

	BR 85-29009 x FT-2	BR 85-29009 x BR-13	BR 85-29009 x OC-8	FT-2 x BR-13	FT-2 x OC-8	BR-13 x OC-8
			(i) First Sowing Date			
D	24.14 ± 7.78	27.59 ± 7.67	167.14 ± 23.74	-	27.80 ± 7.65	76.94 ± 12.88
D1	-	-	-	27.72 ± 6.13	-	-
D2	-	-	-	58.09 ± 16.59	-	-
H	-	-	-	-	-	-
F	-	-	-	-	-	-
E	23.22 ± 3.29	19.52 ± 2.95	25.90 ± 5.06	12.30 ± 2.21	18.75 ± 2.86	18.19 + 3.30
E1	-	-	-	-	-	-
E2	-	-	-	-	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	4.56	4.10	3.05	4.99	3.51	5.07
df	3	3	3	2	3	3

(ii) Second Sowing Date

D	38.52 ± 12.30	53.03 ± 15.71	67.61 ± 20.91	64.59 ± 14.96	33.71 ± 11.99	-
D1	-	-	-	-	-	61.91 ± 15.13
D2	-	-	-	-	-	-
H	-	-	-	-	-	-
F	-	-	-	-	-	-
E	-	39.44 ± 6.35	56.58 ± 8.52	28.08 ± 14.96	-	36.19 ± 4.17
E1	46.25 ± 10.23	-	-	-	54.69 ± 10.74	-
E2	14.08 ± 3.77	-	-	-	15.04 ± 4.02	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	2.74	6.36	1.65	7.36	2.54	3.35
df	2	3	3	3	2	3

(iii) Third Sowing Date

D	58.32 ± 16.19	75.45 ± 20.46	106.09 ± 21.30	52.82 ± 14.24	52.25 ± 14.14	87.42 ± 19.10
D1	-	-	-	-	-	-
D2	-	-	-	-	-	-
H	-	-	-	-	-	-
F	-	-	-	-	-	-
E	37.23 ± 6.00	48.76 ± 7.54	37.03 ± 6.32	31.34 ± 5.06	31.46 ± 5.06	34.71 ± 5.98
E1	-	-	-	-	-	-
E2	-	-	-	-	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	1.85	5.27	1.47	0.52	0.55	1.52
df	3	3	3	3	3	3

TABLE VII. Genetic parameters adjusted to the means of days from germination to flowering.

	BR 85-29009 x FT-2	BR 85-29009 x BR-13	BR 85-29009 x OC-8	FT-2 x BR-13	FT-2 x OC-8	BR-13 x OC-8
			(i) First Sowing Date			
m	42.22 ± 0.19	39.73 ± 0.21	48.33 ± 0.26	39.02 ± 0.88 1/	41.81 ± 0.25	40.04 ± 0.32
[d]	4.69 ± 0.35	5.63 ± 0.25	1.63 ± 0.43	1.77 ± 0.22	6.00 ± 0.35	7.77 ± 0.30
[h]	-	-	-	-6.08 ± 1.92	-	-
[i]	-	-	-	-3.07 ± 0.91	1.91 ± 0.43	1.92 ± 0.44
[j]	-	-	-	-	-	-
[l]	-	-	-	-	-	-
2	n.s	n.s	n.s		n.s	n.s
X	2.25	5.46	0.68	-	2.86	1.51
df	2	2	2	-	1	1

(ii) Second Sowing Date

m	48.25 ± 0.16	43.76 ± 0.71 1/	49.62 ± 0.75	42.39 ± 0.23	48.22 ± 0.15 1/	45.30 ± 0.21
[d]	4.09 ± 0.25	7.05 ± 0.25	1.15 ± 0.23	2.96 ± 0.24	2.95 ± 0.21	5.90 ± 0.22
[h]	-	3.92 ± 1.79	5.52 ± 1.98	1.46 ± 0.66	-	1.96 ± 0.85
[i]	1.14 ± 0.30	2.67 ± 0.75	2.72 ± 0.78	-	-	-
[j]	-	-	-	-	-	-
[l]	-	-	-	-	-	-
2	n.s			n.s	n.s	n.s
X	0.41	-	-	0.37	1.73	0.14
df	1	-	-	1	2	1

(iii) Third Sowing Date

m	45.71 ± 0.10	44.34 ± 0.10	47.50 ± 0.11	42.31 ± 0.13	46.12 ± 0.15	43.44 ± 0.13
[d]	2.08 ± 0.14	3.93 ± 0.13	0.89 ± 0.14	1.85 ± 0.13	1.18 ± 0.14	3.03 ± 0.13
[h]	-	-	-	1.42 ± 0.45	-	1.82 ± 0.55
[i]	0.48 ± 0.17	-	-	-	-0.83 ± 0.20	-
[j]	-	-	-	-	-	-
[l]	-	-	-	-	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	2.69	1.73	2.63	1.85	1.34	0.01
df	1	2	2	1	1	1

1/ Perfect fit; no degree of freedom left for testing the model goodness of fit.

TABLE VIII. Genetic parameters adjusted to the variances of days from germination to flowering.

	BR 85-29009 x FT-2	BR 85-29009 x BR-13	BR 85-29009 x OC-8	FT-2 x BR-13	FT-2 x OC-8	BR-13 x OC-8
			(i) First Sowing Date			
D	10.63 ± 2.71	19.62 ± 4.08	30.29 ± 6.04	- 1/	-	32.90 ± 4.44
D1	-	-	-	-	17.19 ± 3.37	-
D2	-	-	-	-	-	-
H	-	-	-	-	-	-
F	-	-	-	-	-	-
E	6.37 ± 0.98	-	10.52 ± 1.82	-	6.59 ± 0.72	-
E1	-	11.88 ± 2.68	-	-	-	6.96 ± 1.90
E2	-	0.86 ± 0.24	-	-	-	0.83 ± 0.23
2	n.s	n.s	n.s		n.s	n.s
X	6.40	0.50	4.30	-	2.76	3.98
df	3	2	3	-	3	2

(ii) Second Sowing Date

D	5.28 ± 1.40	16.10 ± 2.65	21.33 ± 2.80	- 1/	12.34 ± 1.93	-
D1	-	-	-	-	-	25.40 ± 3.79
D2	-	-	-	-	-	50.63 ± 8.30
H	-	-	-	-	-	-
F	-	-	-	-	-	-
E	3.37 ± 0.51	3.70 ± 0.68	2.76 ± 0.53	-	2.51 ± 0.45	2.35 ± 0.48
E1	-	-	-	-	-	-
E2	-	-	-	-	-	-
2	n.s	n.s	n.s		n.s	n.s
X	1.08	2.03	6.45	-	2.17	1.35
df	3	3	3		3	2

(iii) Third Sowing Date

D	2.17 ± 0.53	6.26 ± 0.90	15.09 ± 1.69	5.56 ± 0.80	7.66 ± 1.07	10.24 ± 1.22
D1	-	-	-	-	-	-
D2	-	-	-	-	-	-
H	-	-	-	-	-	-
F	-	-	-	-	-	-
E	1.18 ± 0.19	1.05 ± 0.19	1.06 ± 0.20	0.93 ± 0.17	1.20 ± 0.22	0.99 ± 0.18
E1	-	-	-	-	-	-
E2	-	-	-	-	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	1.43	1.55	3.12	2.12	2.87	4.74
df	3	3	3	3	3	3

1/ No satisfactory model was found.

TABLE IX. Genetic parameters adjusted to the means of number of trifoliolate leaf nodes.

	BR 85-29009 x FT-2	BR 85-29009 x BR-13	BR 85-29009 x OC-8	FT-2 x BR-13	FT-2 x OC-8	BR-13 x OC-8
			(i) First Sowing Date			
m	9.85 ± 0.09	9.12 ± 0.09	12.27 ± 0.13	9.33 ± 0.34 [1/]	10.16 ± 0.10	9.58 ± 0.12
[d]	1.44 ± 0.18	1.72 ± 0.17	1.12 ± 0.21	0.40 ± 0.16	2.57 ± 0.19	2.97 ± 0.18
[h]	-	-	-	-2.04 ± 0.79	-	-
[i]	-	-	-	-1.32 ± 0.37	0.82 ± 0.22	1.01 ± 0.22
[j]	-	-	-	-	-	-
[l]	-	-	-	-	-	-
2	n.s	n.s	n.s		n.s	n.s
X	0.01	5.37	1.42	_	0.58	1.12
df	2	2	2	_	1	1

(ii) Second Sowing Date

m	12.34 ± 0.08	11.42 ± 0.17	12.67 ± 0.16	11.14 ± 0.10	12.30 ± 0.18 [1/]	11.44 ± 0.17
[d]	0.47 ± 0.18	1.18 ± 0.20	-	0.71 ± 0.18	0.55 ± 0.18	1.29 ± 0.19
[h]	-	1.27 ± 0.48	1.55 ± 0.46	-	5.90 _ 1.50	1.71 ± 0.50
[i]	-	-	-	-	-	-
[j]	-	-	-	-	-	-
[l]	-	-	-	-	-11.12 ± 2.75	-
2	n.s	n.s	n.s	n.s		n.s
X	1.65	0.32	0.89	0.59	-	1.89
df	2	1	2	2	-	1

(iii) Third Sowing Date

m	12.75 ± 0.10	12.59 ± 0.10	13.73 ± 0.09	12.60 ± 0.10	13.42 ± 0.10	12.79 ± 0.15
[d]	-	0.86 ± 0.23	-	0.51 ± 0.22	0.61 ± 0.19	1.10 ± 0.18
[h]	-	-	-	-	-	1.06 ± 0.44
[i]	-	-	-	-	-	-
[j]	-	-	-	-	-	-
[l]	-	-	-	-	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	4.15	1.08	4.28	5.00	5.57	0.32
df	3	2	3	2	2	1

1/ Perfect fit; no degree of freedom left for testing the model goodness of fit.

TABLE X. Genetic parameters adjusted to the variances of number of trifoliolate leaf nodes.

	BR 85-29009 x FT-2	BR 85-29009 x BR-13	BR 85-29009 x OC-8	FT-2 x BR-13	FT-2 x OC-8	BR-13 x OC-8
			(i) First Planting Date			
				1/		
D	1.61 ± 0.52	1.13 ± 0.47	6.40 ± 1.36	-	-	3.18 ± 0.79
D1	-	-	-	-	1.85 ± 0.51	-
D2	-	-	-	-	-	-
H	-	-	-	-	-	-
F	-	-	-	-	-	-
E	1.58 ± 0.22	1.79 ± 0.23	2.48 ± 0.43	-	1.55 ± 0.17	1.75 ± 0.28
E1	-	-	-	-	-	-
E2	-	-	-	-	-	-
2	n.s	n.s	n.s		n.s	n.s
X	2.35	3.10	2.31	-	4.94	3.53
df	3	3	3	-	3	3

(ii) Second Planting Date

D	0.97 ± 0.44	1.70 ± 0.61	-	2.54 ± 0.71	-	2.26 ± 0.61
D1	-	-	-	-	-	-
D2	-	-	-	-	-	-
H	-	-	-	-	-	-
F	-	-	-	-	-	-
E	1.59 ± 0.22	1.84 ± 0.27	2.22 ± 0.19	1.63 ± 0.26	2.10 ± 0.17	1.38 ± 0.23
E1	-	-	-	-	-	-
E2	-	-	-	-	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	3.28	2.09	3.64	0.36	6.97	5.71
df	3	3	4	3	4	3

(iii) Third Planting Date

D	-	-	1.27 ± 0.56	-	1.37 ± 0.60	1.37 ± 0.50
D1	-	-	-	-	-	-
D2	-	-	-	-	-	-
H	-	-	-	-	-	-
F	-	-	-	-	-	-
E	2.67 ± 0.23	2.64 ± 0.22	-	2.58 ± 0.22	2.25 ± 0.30	1.68 ± 0.22
E1	-	-	1.22 ± 0.31	-	-	-
E2	-	-	3.05 ± 0.59	-	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	9.02	7.33	5.77	4.40	4.65	2.48
df	4	4	2	4	3	3

1/ No satisfactory model was found.

TABLE XI. Genetic parameters adjusted to the means of average lenght of plant internode.

	BR 85-29009 x FT-2	BR 85-29009 x BR-13	BR 85-29009 x OC-8	FT-2 x BR-13	FT-2 x OC-8	BR-13 x OC-8
			(i) First Sowing Date			
m	3.00 ± 0.03	3.37 ± 0.07	3.33 ± 0.03	3.23 ± 0.03	3.17 ± 0.02	3.43 ± 0.05
[d]	0.18 ± 0.06	-	0.16 ± 0.07	0.30 ± 0.05	0.34 ± 0.05	-
[h]	-	-2.47 ± 0.54	-	-	-	-0.44 ± 0.14
[i]	-	-	-	-	-	-
[j]	-	-	-	-	-	-
[l]	-	3.29 ± 0.95	-	-	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	1.29	0.96	1.44	5.33	1.35	3.62
df	2	1	2	2	2	2

(ii) Second Sowing Date

m	3.98 ± 0.06	3.64 ± 0.03	4.46 ± 0.08	3.78 ± 0.03	3.99 ± 0.03	4.13 ± 0.07
[d]	0.31 ± 0.07	0.29 ± 0.08	-	-	0.35 ± 0.07	0.36 ± 0.08
[h]	-0.58 ± 0.17	-	-2.63 ± 0.72	-	-	-0.67 ± 0.19
[i]	-	0.45± 0.08	-	-	-	-
[j]	-	-	-	-	-	-
[l]	-	-	4.31 ± 1.28	-	-	-
2	n.s		n.s	n.s	n.s	n.s
X	3.09	3.29	1.13	1.51	5.29	1.60
df	1	1	1	3	2	1

(iii) Third Sowing Date

m	5.57 ± 0.08	5.42 ± 0.07	5.78 ± 0.07	5.44 ± 0.04	5.82 ± 0.04	5.67 ± 0.04
[d]	-	-	0.22 ± 0.08	-	0.16 ± 0.08	0.31 ± 0.07
[h]	-0.53 ± 0.24	-0.54 ± 0.23	-0.57 ± 0.22	-	-	-
[i]	-	-	-	-	-	-
[j]	-	-	-	-	-	-
[l]	-	-	-	-	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	0.71	0.86	0.47	2.64	3.13	0.35
df	2	2	1	3	2	2

TABLE XII. Genetic parameters adjusted to the variances of average length of plant internode.

	BR 85-29009 x FT-2	BR 85-29009 x BR-13	BR 85-29009 x OC-8	FT-2 x BR-13	FT-2 x OC-8	BR-13 x OC-8
			(i) First Sowing Date			
D	0.13 ± 0.05	-	0.08 ± 0.04	0.19 ± 0.06	-	-
D1	-	-	-	-	-	0.07 ± 0.04
D2	-	-	-	-	-	-
H	-	-	-	-	-	-
F	-	-	-	-	-	-
E	-	0.25 ± 0.02	0.20 ± 0.02	0.19 ± 0.03	0.17 ± 0.01	0.16 ± 0.02
E1	0.26 ± 0.05	-	-	-	-	-
E2	0.13 ± 0.03	-	-	-	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	4.76	4.45	5.82	3.22	6.92	2.16
df	2	4	3	3	4	3

(ii) Second Sowing Date

m	3.98 ± 0.06	3.64 ± 0.03	4.46 ± 0.08	3.78 ± 0.03	3.99 ± 0.03	4.13 ± 0.07
[d]	0.31 ± 0.07	0.29 ± 0.08	-	-	0.35 ± 0.07	0.36 ± 0.08
[h]	-0.58 ± 0.17	-	-2.63 ± 0.72	-	-	-0.67 ± 0.19
[i]	-	0.45± 0.08	-	-	-	-
[j]	-	-	-	-	-	-
[l]	-	-	4.31 ± 1.28	-	-	-
2	n.s		n.s	n.s	n.s	n.s
X	3.09	3.29	1.13	1.51	5.29	1.60
df	1	1	1	3	2	1

(iii) Third Sowing Date

m	5.57 ± 0.08	5.42 ± 0.07	5.78 ± 0.07	5.44 ± 0.04	5.82 ± 0.04	5.67 ± 0.04
[d]	-	-	0.22 ± 0.08	-	0.16 ± 0.08	0.31 ± 0.07
[h]	-0.53 ± 0.24	-0.54 ± 0.23	-0.57 ± 0.22	-	-	-
[i]	-	-	-	-	-	-
[j]	-	-	-	-	-	-
[l]	-	-	-	-	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	0.71	0.86	0.47	2.64	3.13	0.35
df	2	2	1	3	2	2

TABLE XII. Genetic parameters adjusted to the variances of average length of plant internode.

	BR 85-29009 x FT-2	BR 85-29009 x BR-13	BR 85-29009 x OC-8	FT-2 x BR-13	FT-2 x OC-8	BR-13 x OC-8
			(i) First Sowing Date			
D	0.13 ± 0.05	-	0.08 ± 0.04	0.19 ± 0.06	-	-
D1	-	-	-	-	-	0.07 ± 0.04
D2	-	-	-	-	-	-
H	-	-	-	-	-	-
F	-	-	-	-	-	-
E	-	0.25 ± 0.02	0.20 ± 0.02	0.19 ± 0.03	0.17 ± 0.01	0.16 ± 0.02
E1	0.26 ± 0.05	-	-	-	-	-
E2	0.13 ± 0.03	-	-	-	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	4.76	4.45	5.82	3.22	6.92	2.16
df	2	4	3	3	4	3

(ii) Second Sowing Date

D	-	0.09 ± 0.05	0.26 ± 0.09	0.10 ± 0.05	-	-
D1	-	-	-	-	-	0.14 ± 0.07
D2	-	-	-	-	-	-
H	-	-	-	-	-	-
F	-	-	-	-	-	-
E	0.25 ± 0.02	0.22 ± 0.03	0.28 ± 0.04	0.23 ± 0.03	0.32 ± 0.03	0.29 ± 0.03
E1	-	-	-	-	-	-
E2	-	-	-	-	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	7.78	3.50	5.83	2.25	6.80	3.19
df	4	3	3	3	4	3

(iii) Third Sowing Date

D	-	0.37 ± 0.13	0.42 ± 0.12	-	-	0.18 ± 0.09
D1	-	-	-	-	-	-
D2	-	-	-	-	-	-
H	-	-	-	-	-	-
F	-	-	-	-	-	-
E	0.47 ± 0.02	0.44 ± 0.06	0.32 ± 0.05	0.49 ± 0.04	0.47 ± 0.04	0.37 ± 0.04
E1	-	-	-	-	-	-
E2	-	-	-	-	-	-
2	n.s	n.s	n.s	n.s	n.s	n.s
X	7.78	1.80	6.13	6.74	6.95	5.92
df	4	3	3	4	4	3

TABLE XIII. Single plant heritability for final plant height (FH), days from germination to flowering (DF), number of trifoliolate nodes (NN) and average internode length (IL).

CROSS	FH	DF	NN	IL
	(i) First Sowing Date			
BR85-29009 X FT-2	0.51	0.62	0.50	0.40
BR85-29009 X BR-13	0.59	0.75	0.39	0.00
BR85-29009 X OC-8	0.87	0.74	0.72	0.29
FT-2 X BR-13	0.78	-	-	0.50
FT-2 X OC-8	0.60	0.72	0.54	0.00
BR-13 X OC-8	0.81	0.89	0.65	0.30
	(ii) Second Sowing Date			
BR85-29009 X FT-2	0.56	0.61	0.38	0.00
BR85-29009 X BR-13	0.57	0.81	0.48	0.29
BR85-29009 X OC-8	0.54	0.89	0.00	0.48
FT-2 X BR-13	0.70	-	0.61	0.30
FT-2 X OC-8	0.49	0.83	0.00	0.00
BR-13 X OC-8	0.63	0.94	0.62	0.33
	(iii) Third Sowing Date			
BR85-29009 X FT-2	0.61	0.65	0.00	0.00
BR85-29009 X BR-13	0.61	0.86	0.00	0.46
BR85-29009 X OC-8	0.74	0.93	0.37	0.57
FT-2 X BR-13	0.63	0.86	0.00	0.00
FT-2 X OC-8	0.62	0.86	0.38	0.00
BR-13 X OC-8	0.72	0.91	0.45	0.33

TABLE XIV. Phenotypic correlation between final plant height (FH), days from germination to flowering (DF), number of trifoliolate leaf nodes (NN) and average internode length (IL).

	FH	DF	NN	IL
		(i) First Sowing Date		
FH	1.0000	0.9179	0.9706	0.6716
DF	-	1.0000	0.9822	0.3605
NN	-	-	1.0000	0.4830
IL	-	-	-	1.0000
		(ii) Second Sowing Date		
FH	1.0000	0.9265	0.8748	0.8861
DF	-	1.0000	0.9134	0.7221
NN	-	-	1.0000	0.5518
IL	-	-	-	1.0000
		(iii) Third Sowing Date		
FH	1.0000	0.6580	0.9020	0.8766
DF	-	1.0000	0.8304	0.3326
NN	-	-	1.0000	0.5876
IL	-	-	-	1.0000

TABLE XV. Predicted proportion of random imbred lines scoring > OC-8 for final plant height (FH) ,days from germination to flowering (DF), number of trifoliolate leaf nodes (NN) and average internode length (IL).

CROSS	FH	DF	NN	IL
		(i) First Sowing Date		
BR85-29009 X FT-2	0.0000	0.0107	0.0018	0.0630
BR85-29009 X BR-13	0.0000	0.0119	0.0000	-
BR85-29009 X OC-8	0.3050	0.4013	0.3050	0.2177
FT-2 X BR-13	0.2981	-	-	0.2327
FT-2 X OC-8	0.0014	0.0281	0.0062	-
BR-13 X OC-8	0.0294	0.0455	0.0129	0.3264
		(ii) Second Sowing Date		
BR85-29009 X FT-2	0.0618	0.1003	0.3015	-
BR85-29009 X BR-13	0.0516	0.0322	0.1357	0.0011
BR85-29009 X OC-8	0.4364	0.3669	-	0.4207
FT-2 X BR-13	0.0217	-	0.1423	0.0068
FT-2 X OC-8	0.0934	0.1977	-	-
BR-13 X OC-8	0.0655	0.1685	0.1736	0.1251
		(iii) Third Sowing Date		
BR85-29009 X FT-2	0.0618	0.3015	-	-
BR85-29009 X BR-13	0.0384	0.1949	-	0.1736
BR85-29009 X OC-8	0.3156	0.6026	0.4286	0.3745
FT-2 X BR-13	0.0116	0.0384	-	-
FT-2 X OC-8	0.1736	0.4483	0.3300	-
BR-13 X OC-8	0.1314	0.1711	0.1660	0.2266

TABLE XVI. Distribution of the parental, F2 and F3 individual plant scores for final plant height.

Genotype	(i) First Sowing Date																																
	13	16	19	22	25	28	31	34	37	40	43	46	49	52	55	58	61	64	67	70	73	76	79	82	85	88	91	94	97	100	103	106	109
	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	81	84	87	90	93	96	99	102	105	108	111
FT-2	01	03	02	07	11	05																											
BR-13			02	09	10	05	02																										
BR 85-29009					01	02	07	03	04	04	02																						
OC-8									02	03	02	05	06	05	02																		
BR 85-29009 x FT-2																																	
F2	02	04	16	23	18	20	15	11	03	01	01																						
F3	01	10	24	30	23	19	15	10	08	04	01																						
BR 85-29009 x BR-13																																	
F2	01	02	02	16	26	30	14	09	09	04	01																						
F3		04	09	15	31	30	22	15	09	05	01	00	01	00	00	00	01																
BR 85-29009 x OC-8																																	
F2			02	06	06	11	05	10	08	09	10	12	07	09	04	04	03	01	01														
F3		01	02	02	09	14	19	14	20	12	05	09	10	10	08	03	02	03	02														
FT-2 x BR-13																																	
F2	02	01	17	17	37	21	12	07	02																								
F3	01	05	10	19	27	41	19	06	15	00	01	00	01	01	00	00	01																
FT-2 x OC-8																																	
F2			02	04	18	25	23	16	16	04	03	02																					
F3			03	14	22	20	31	15	15	09	06	03	02																				
BR-13 x OC-8																																	
F2	01	01	03	12	20	23	18	08	10	07	02	04	01	02																			
F3		03	04	22	28	17	23	11	07	05	08	03	02	03	00	00	00	00	01														

cont...

TABLE XVI. cont.

Genotype	(ii) Second Sowing Date																																
	13	16	19	22	25	28	31	34	37	40	43	46	49	52	55	58	61	64	67	70	73	76	79	82	85	88	91	94	97	100	103	106	109
	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	81	84	87	90	93	96	99	102	105	108	111
FT-2								01	03	10	08	02	03	01																			
BR-13					01	01	02	01	06	04	02	04																					
BR 85-29009						01	00	00	00	00	01	00	06	03	04	06	02	01															
OC-8												04	01	03	06	02	04	01	03	02													
BR 85-29009 x FT-2																																	
F2				01	02	03	07	09	08	14	23	25	13	03	03	02	01																
F3				01	03	05	11	11	12	15	11	13	12	17	09	05	01	00	01														
BR 85-29009 x BR-13																																	
F2						01	00	03	11	08	32	15	15	08	04	02	03	01															
F3					03	01	02	05	15	13	22	21	15	14	04	00	01	01	01	00	00	00	00	01									
BR 85-29009 x OC-8																																	
F2								01	01	06	03	08	08	17	07	16	10	11	08	04	02												
F3						01	02	00	08	11	18	16	15	12	13	13	10	07	01	04	04	01	00	01	00	00	01						
FT-2 x BR-13																																	
F2					02	06	06	09	12	23	11	19	07	07	03																		
F3					02	10	11	16	13	13	23	19	08	08	04	02	01	00	00	02	00	00	00	00	01								
FT-2 x OC-8																																	
F2							02	01	04	10	22	15	21	09	09	03	04	01	03	00	00	01											
F3									02	08	13	31	21	28	12	07	04	03	03	02	00	00	00	00	01								
BR-13 x OC-8																																	
F2					01	03	00	04	08	13	14	15	13	16	09	06	01	00	01														
F3				01	02	04	06	07	05	16	21	09	23	18	10	04	02																

cont...

TABLE XVI. cont.

Genotype	(iii) Third Sowing Date																														
	13	16	19	22	25	28	31	34	37	40	43	46	49	52	55	58	61	64	67	70	73	76	79	82	85	88	91	94	97	100	103	106	109
	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	81	84	87	90	93	96	99	102	105	108	111
FT-2																01	02	02	04	06	05	02	01										
BR-13													01	00	04	06	04	06	04	02	01												
BR 85-29009																	01	02	04	05	05	04	04	00	00	00	00	01					
OC-8																		01	00	00	03	02	01	11	05	04	01	01					
BR 85-29009 x FT-2																																	
F2									01	00	02	00	05	04	06	14	17	16	15	09	03	05	03	03	04	01	02	00	00	01			
F3										01	01	01	05	13	11	13	18	18	13	17	08	05	05	02	01	01	02	01	00	01			
BR 85-29009 x BR-13																																	
F2									01	00	02	00	02	00	01	07	18	15	20	12	06	05	07	02	01	00	00	00	01				
F3						01	00	01	00	01	00	01	01	01	07	09	17	19	23	14	15	08	07	06	01								
BR 85-29009 x OC-8																																	
F2													01	02	02	06	05	07	20	13	10	11	09	08	08	03	01	01	03				
F3												01	01	01	03	03	04	13	09	14	11	20	19	08	09	05	06	03	01	02			
FT-2 x BR-13																																	
F2										01	00	00	02	01	03	02	10	14	18	16	11	06	05	02	02								
F3									01	00	00	00	05	05	02	06	12	18	23	22	14	11	07	04	01	00	01						
FT-2 x OC-8																																	
F2											01	00	00	01	01	01	02	04	09	06	16	11	13	19	09	06	02	01	02				
F3											02	00	00	01	01	02	05	01	08	07	15	18	23	18	10	11	03	03	01				
BR-13 x OC-8																																	
F2																03	07	04	13	13	14	18	15	12	09								
F3													01	01	02	08	07	14	19	19	14	11	10	19	08	03	02	00	00	00	00	01	

TABLE XVII. Distribution of the parentals, F2 and F3 individual plant scores for the number of days from germination to the opening of the first flower.

Genotype	(i) First Sowing Date																															
	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
FT-2					02	03	05	03	06	02	05	02	01																					
BR-13			01	04	13	07	02																											
BR 85-29009																03	05	06	02	03	03	01					01							
OC-8																01	01	03	05	03	03	04	02		02				01					
BR 85-29009 x FT-2																																		
F2				01		01		09	08	11	13	09	16	09	14	08	08	06		01	02													
F3					01	02	05	09	13	09	09	12	09	15	10	14	12	13	08		01							01						
BR 85-29009 x BR-13																																		
F2		02		03	05	06	07	17	14	11	11	04	07	04	04	05	06	04	02	02													
F3		01	01	07	14	13	15	12	11	07	07	09	07	10	07	09	06	05	03														
BR 85-29009 x OC-8																																		
F2								02	02	01	01	07	05	01	05	08	09	02	08	13	07	05	09	05	05	02	04	03		01	02			02
F3									01	02	03	04	09	07	12	10	06	17	09	07	06	06	09	10	06	07	03	06	03	02				
FT-2 x BR-13																																		
F2		01	03	08	20	26	17	16	09	03	08	02	02	01																			
F3	04	04	08	14	15	10	15	11	16	13	09	14	02	03	01	02	01	01		01	01			01			01				01		01	
FT-2 x OC-8																																		
F2						01	06	07	08	12	08	07	08	08	12	10	12	04	05	05														
F3			01		02	07	12	13	08	13	06	09	10	15	08	10	07	09	05	05		02												
BR-13 x OC-8																																		
F2		01	01	03	05	06	08	12	08	08	11	09	06	07	06	05	03	04	02	02	03	02		01										
F3	01	05	03	09	09	06	12	12	09	07	09	11	10	05	05	01	03	04	04	05	05	01		02										

cont...

TABLE XVII. cont.

Genotype	(ii) Second Sowing Date																																			
	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	-	74
FT-2													01	03	07	06	05	02	04	01																	
BR-13							01	03	03	04	08	03	01	01																							
BR 85-29009																					03	03		06	06	06	02	01									
OC-8																				01	08	08	06	01	01	01											
BR 85-29009 x FT-2																																					
F2														03	06	06	06	13	21	25	16	10	04	01	01	01											
F3												02		10	08	09	10	09	21	23	17	13	09	04	02	01											
BR 85-29009 x BR-13																																					
F2									01	03	05	10	04	10	08	15	05	08	20	12	08	05	02														
F3						01			02	07	13	09	07	19	13	11	08	16	09	13	10	01		01	01	01											
BR 85-29009 x OC-8																																					
F2														01	03	01	02	04	05	11	07	16	09	09	08	10	08	09	02		04	01			01		
F3												01		02	04	03	04	07	13	17	19	14	12	15	07	06	06	06	01	02	03	01					
FT-2 x BR-13																																					
F2								01	02	03	09	14	12	23	21	07	09	04	04	01																	
F3					01	06	02	03	04	13	04	14	13	20	17	16	09	02	02	04	04	03			02					01							
FT-2 x OC-8																																					
F2														05	06	10	13	05	15	13	12	10	11	07	02												
F3											01	02	07	05	12	15	05	14	11	19	14	16	07	05	04	03											
BR-13 x OC-8																																					
F2						01	01	01	02		03	05	05	10	09	04	11	06	14	10	12	06	06	01													
F3							01	04	06	05	11	06	05	05	09	06	11	04	18	19	07	09	07	04	01												01

cont..

TABLE XVII. cont.

(iii) Third Sowing Date

Genotype	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
FT-2												01	01	03	13	09	01																	
BR-13									01	02	14	09	02	01																				
BR 85-29009																	02	02	11	09	02													
OC-8															01	03	12	07	06															
BR 85-29009 x FT-2																																		
F2														0	1	2	2	3	0	0														
F3										0			0	0	2	2	3	2	0	0														
BR 85-29009 x BR-13																																		
F2											3	2	3	4	3	7	9	8	1															
F3										3	6	0	2	4	3	5	6	1	0	2	1													
BR 85-29009 x OC-8																																		
F2												03	06	04	06	04	12	13	15	17	12	07	05	02	03	01								
F3													04	09	08	10	14	23	16	16	06	08	11	07	03	01								
FT-2 x BR-13																																		
F2									01	02	08	18	16	22	23	11	06	03	01															
F3								01		01	17	19	25	34	18	11	10	01	03						01	01								
FT-2 x OC-8																																		
F2										01	01	03	04	15	12	25	24	11	04	07	01													
F3											02	03	03	12	13	13	22	25	21	17	09													
BR-13 x OC-8																																		
F2										01	09	04	09	10	22	13	15	10	07	04	01		01											
F3									03	04	07	17	18	14	26	12	17	09	12	03	01		01											

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RESUMO

A soja é uma planta de dias curtos, altamente influenciada pelo fotoperíodo. A resposta ao comprimento do dia é determinada pelo genótipo e o controle genético de dias para o florescimento (altamente correlacionada com a altura das plantas) em dias curtos e longos foi descrito como distinto e independente. Neste trabalho, quatro genótipos parentais escolhidos pela resposta às variações do comprimento do dia (BR85-29009, FT-2 e BR-13, como tipos clássicos de resposta e OC-8, como portadora da característica período juvenil) foram cruzados para obter seis conjuntos de gerações F2 e F3. A resposta dos materiais às variações do comprimento do dia foram estudadas através da análise das características altura final da planta, dias para o florescimento, número de nós e comprimento médio do entrenó. Foram também analisados os mecanismos genéticos em controle dessas características nos seis conjuntos de parentais e gerações F2 e F3 disponíveis. As variações no fotoperíodo foram obtidas realizando a semeadura em três épocas distintas (setembro, outubro e novembro) em Londrina situada a 23°23' latitude. Os resultados mostraram que os efeitos aditivos predominam no controle genético de todas as características. A seleção para adaptação deve ser realizada em cada época de semeadura, através da seleção das plantas pela altura diretamente ou através do número de dias para a floração. Os resultados também mostraram que o mecanismo genético em controle de dias para o florescimento de soja é quantitativo e provavelmente único para as três épocas de semeadura.

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