

## **The Effects of Daylength on the Growth of Soybean and the Creation of Wide-adaptation Germplasm**

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### Introduction

There are plenty of reports about the photoperiodic response of soybean. The early studies were mainly focused on the effect of daylength on blooming stage. Further studies showed that daylength influences, not only the development of soybean before flowering, but also the development between flowering and maturity (Major 1975, Akhanda et al. 1981, Liu et al. 1983). He et al. (1993) and Han et al. (1995) investigated the post-flowering photoperiodic responses of soybean by treating soybean with different daylengths before and after flowering. These studies together proved that photoperiod affects the whole growth and development period, but few studies have associated photoperiod with yield characters and creation of wide-adaptation lines of soybean.

The goal of this study was to understand the response of cultivars to different daylengths and to create daylength insensitive germplasm. These will provide knowledge and material for high-yield breeding and photoperiodic breeding of soybean.

### Materials and Methods

Experiment 1. In order to determine the effects of daylength on growth and agronomic characters of soybean, four cultivars were selected, which were, or are grown, in different latitudes from northern to southern China (Heihe 5, Heinong 33, Xiangchun 14 and Jindou 1). Plants were potted, with three

plants per pot, three pots per cultivar in randomized blocks. Eight hours and sixteen hours were adopted for photoperiod induction, starting on the day when the first trifoliolate leaf unrolled and continuing for 15 days. The 8h daylength was realized by sheltering the pots from the sunlight at 4 pm and opening at 8 am. The 16h daylength was obtained by lengthening the natural day with 200 W incandescent lamps to 16h at both ends of the day. The natural day was taken as control treatment (approx. 13.5h). All the developmental stages were recorded during the growing period. All the plants were harvested at maturity and the agronomic characters were measured. The experiment was conducted at Harbin (45° 41' N latitude) for two years.

Experiment 2. Two hundred progenies containing superior parent genotypes, which are geographically distant, or from ecological environments with great differences, were selected. They were grown at Hainan Island and Harbin for screening and lines were identified which are insensitive to photoperiod. The preliminarily selected lines were also evaluated at Beijing and Harbin. At Hainan Island, the natural short daylength was used. At Harbin and Beijing, the materials were grown in pots, 3 plants each pot and 3 pots per line, and treated with short daylength (8h) at V2 growth stage, with the natural daylength as control treatment. The criteria for wide adaptation are that the value of  $(T-CK)/CK$  is less than 20%, where T is the number of days from  $V_e$  to R1 or plant height of the lines treated with short daylength and CK is the corresponding value of control treatment, and the grain yield is not lower than that of local popularized cultivars by multi-spots tests.

## Results and Discussion

### Effects of daylength on stages of vegetative growth and development of leaves

Daylength had a notable effect on the length of the period from  $V_e$  to R1. Cultivars from different geographic latitudes had different reactions (Table 1). There was a small difference of days from  $V_e$  to R1 between 16h daylength and natural daylength. Between 8h and natural daylengths, the difference was small for Heihe 5 and Heinong 33, but big for Xiangchun 14 and Jindou 1, decreasing 13d and 14d respectively. This indicates that Heihe 5 and Heinong 33 are insensitive and Xiangchun 14 and Jindou 1 are sensitive to daylength.

Under long daylength, the lengths From  $V_e$  to  $V_t$  in Heihe 5 and Heinong 33 were a little longer than those under natural daylength. But there was no notable difference for Xiangchun14 and Jindou1. Under 8h daylength, the periods from  $V_e$  to  $V_t$  of all four cultivars shortened to different extents, more for cultivars sensitive to daylength and less for cultivars insensitive to daylength (Table 1).

There were small differences of the number of total leaves of the cultivars between 16h daylength and natural daylength. Under 8h daylength, the number of total leaves of all the cultivars decreased, more for cultivars sensitive to daylength and less for cultivars insensitive to daylength. For the growth rate of leaves, the days needed for each leaf growth in Heihe5 were a little more under short daylength, but in the other three cultivars there were no differences between daylengths. This indicates that there is little relationship between the length Of  $V_e$  to  $V_t$  period and the growth rate of leaves under different daylengths.

#### Effect of daylength on stages of reproductive growth of soybean

For the period of R1 to R8, there were small differences between 16h and natural daylengths. But under 8h daylength, the period of all the cultivars shortened. The stages of R1 to R2 and R2 to R4 in Heihe 5 and Heinong 33 shortened significantly under 8h daylength and the stage of R5 to R7 in Jindou 1 lengthened notably under the 8h daylength (Table 1).

#### Effects of daylength on agronomic characters of soybean

Short daylength (8h) shortened the plant height significantly at maturity and the number of nodes on main stem decreased. The number of branches decreased as the daylength shortened (Table 2).

The number of pods per plant in Heihe 5 and Heinong 33 decreased under 8h short daylength, but in Xiangchun 14, decreased under 16h long daylength, and in Jindou 1, changed little between long and short daylengths. The seed weight per plant was in a complex performance. The seed weight of Heihe 5 decreased as the daylength shortened, while the seed weight of Xiangchun 14 increased as the daylength shortened; and that of Heinong 33 decreased slightly under 16h and 8h daylengths compared

with those grown under natural daylength. The 100-seed weight of Heihe 5 and Heinong 33 changed little under different daylengths, but those of Xiangchun 14 and Jindou 1 increased under 8h daylength (Table 2).

### Creation of wide-adaptation germplasm

In 1991 and 1992, photoperiod screening was conducted on over 200 lines resulting from crossing progenies at Hainan Island (natural short daylength) and Harbin (treated with 8h short daylength at V2 stage). More than 20 lines, with smaller changes of the days from Ve to R1 and plant height compared with those under natural daylength, were selected, and 12 lines were developed. The 12 lines were grown in pots and in the field in 1993 and 1994 at Beijing and Harbin for further identification, and were grown in 1994 at Hainan Island again. Three new lines insensitive to photoperiod, Ha91-7116, Ha92-4498 and Ha92-4465 were developed. The experimental results were listed in Table 3, Table 4, Table 5, and Table 6.

The data in the tables showed that the number of days from Ve to R1 in the three lines under short daylength (8h), compared with CK, changed little. The difference percentages were all less than 15%. The yields of the lines were all higher than that of the local cultivar Heinong 33. Therefore, we affirmed these three lines as new soybean germplasm lines insensitive to photoperiod.

Results of the experiment show that daylength influences not only the number of days from emergence to bloom but also the composition of the whole growth and development period of soybean. Therefore when evaluating the photo-sensitivity of cultivars, the changes of whole growth and development procedure should be considered comprehensively.

According to the change of days from Ve to R1, Heihe 5 and Heinong 33 belong to cultivars insensitive to photoperiod. But under 8h daylength, not only their plant height and numbers of branches and nodes on main stem decreased, but also pods and seed weight per plant lowered significantly. Conversely, Xiangchun14 is a photo-sensitive cultivar, but its seed weight per plant increased notably, though the pods per plant changed little. It is clear that the reaction of soybean to photoperiod is very complicated and the relationship between yield factors and photo-sensitivity remains to be studied further.

## References

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