Studies on the Flowering and Fruiting of Summer vs. Autumn Soybean Types

(5) Effects of the day length after flower primordia initiation upon the flowering process with reference to the adaptation to planting time in autumn soybean type

Tadao Nagata
(Hyogo Agricultural College)

Adaptation of soybean to planting time has been of great interest for man long since the ancient time as written in Lu-shi chun-ts'iu (about 250 B.C.), and many works have, hitherto, been made on it as reviewed by Wass(10) and Nagata(9). Nevertheless, in the physiological and ecological aspects of the subject, many problems still remain obscure. In the temperate zone of Asia such as Central and South China and South Japan, the differentiation of summer vs. autumn soybeans—the former is a short season crop planted in April, and the latter a full season crop planted in June to July—is a well known fact as recorded in many old literatures in China, such as Tsi-min yao-shu, and Tien-kung tai-wu, and in Japan, such as Nogyo zensho, Seikai zuseisu and Honzo zuju.

With respect to such responses of the said soybeans, the author had already reported as follows(9) : (1) Variation of seed yield of autumn soybean types corresponding to planting time depended rather on the flowering process than on the percentage of pods to flowers. (2) Autumn soybean type had more flowers in moderate duration in case of planting in June, but fewer ones in too long duration in April planting as shown in Fig. 2, while summer soybean type had abundant flowers in moderate duration when planted in April. (3) The said flowering habit was not affected by such cultural practices as spacing, fertilizers, pinching the top, transplanting and spraying 2, 3, 5-T.

This paper deals with the effect of photoperiod after flower primordia initiation on the flowering habit of autumn soybean type and its possible significance for the adaptability of soybean to planting time.

The author wishes to acknowledge Prof. Kawai of our laboratory, and Emeritus Prof. Enomoto of the Kyoto University for their careful guidances and valuable suggestions.

Material and method

Akanaya-shirodaizu grouped as a typical autumn soybean type belonging to class A VII by the author(9) was planted on May 5 in 1954 and on April 25 in 1955. Seeding in both years was conducted in the earthen were pot of 27 cm diameter filled with the fertilized soil, and two plants in each pot had been grown till maturity. Short day treatments noted in Fig. 1 had been carried out using eight plants per plot.

Result

From such a performance in 1954 as shown in Fig. 1, it is noticed that short day treatment of this experiment had no effect on the beginning of flowering but on the flowering habit. Then the flowering duration was shortened and number of flowers per day increased to a great extent. So far as the experiment was concerned, plants of plot 1 treated after July 20, 17 days prior to flowering, were observed to have less flowers per day as compared with those of plot 2 treated after July 30, 7 days prior flowering. Total flowers per plant were 98.4 in plot 1, 141.2 in plot 2 and 108.4 in control, and the difference between the flowers of plot 2 and of control was significant in 1 percent level.

Performance in 1955 presented in Fig. 1 could clarify the result of the last year described above in detail: Short day starting on August 9, 10 days after the beginning of flowering, had no effect of increasing the flowers per day but those starting on July 25, 5 days prior to flowering, and on July 31, at the beginning of flowering, were effective in the same way as in plot 2 in 1954.

From the results of both years, it was concluded that the effect of short day treatment after flower primordia initiation was made less in both cases, namely too early (plot 1 in 1954) and too late (plot 3 in 1955) treatments, but it was made more in the treatments during the period from a week prior to flowering to the beginning of flowering.

Discussion

A consideration on the adaptation of soybean to planting time

From the data obtained in 1952(9), a relation between the seasonal change of day length and growing process of autumn soybean type
is presented in Fig. 2. In this figure, time
initiating flower primordia in each planting
plot was added supposedly according to the
results of earlier experiments of the author\(^5\),
in which autumn soybean type bloomed 30 days
after the flower primordia initiation when
planted early, but 20 days after the initiation
when planted late.

The autumn soybean type, Akazaya-shirodaizu,
has also been observed by the author to have
the critical day length within the photoperiod
from 14 to 15 hours with respect to flowering
under controlled condition, and it is similar to
that of maturity group \(\text{VII-III}\) in the United States
as ascertained by Parker and Borthwick\(^10\).
In such a phenological view as shown in Fig. 3,
in which day length was estimated basing on
the sun \(6^\circ\) below horizon as Hartwig did\(^9\),
the soybean did not accelerate the flowering under
14 hours day length as compared with 14.5
hours one, while the flowering duration was
shortened more by the day lengths less than
14 hours. Thus the date showing 14.5 hours
day length becomes of the most interest, and is
pointed out on August 13 in Fig. 2.

Considering the day of 14.5 hours day length
and growing process of the soybean seeded in
successive times, it is found that the flowering
started on too early day in plot planted early,
and on too late day when planted late, as
compared with the critical day of 14.5 hours.
Then, the early planting corresponds to plot 3 of
1955 experiment, and the late planting to plot 1
in 1954. In June planting, the flowering started
in the period near the day of 14.5 hours day
length, and then the planting in June is closely
akin to plot 2 in 1954 and plot 1 and 2 in 1955.

This relation of the planting time to the day
length after the flower primordia initiation
appears to suggest a unique part of the effect of
day length which has never been noticed before.

As presented by Garner and Allard first,
the autumn soybean type or late flowering soy-
bean has, hitherto, been mentioned by agron-
mists in Japan to be adaptable to late planting
by reason of moderate days to flowering and
not to early planting because of too long period
to flowering. Many authors have, however, stud-
ed the effect of day length at different ages of
plant and observed different effects in each
growing stage. Eguchi\(^5\) presented the various
groups of plants differing as to the effect of
day length upon the initiation and development of
flower bud, and recognized soybean as a
plant affected by short day length before and
after the time initiating flower primordia.
Moreover, Borthwick and Parker\(^10\), Parker and
Borthwick\(^10\), and Fukui and Yarimizu\(^3\) men-

tioned that day length had differed effects on
is presented in Fig. 2. In this figure, time
each of flowering and pod development or matur-
ity of soybeans.

Those results should be considered to be pre-
senting that soybeans take different day lengths
which are favorable to each growing stage. This
experiment of the author is also suggesting that
the day length after flower primordia initiation
controls the flowering duration and number of
flowers per day of soybean, and the effects of
day length on them differ to some extent from
that on the flower primordia initiation or the
beginning of flowering, as observed in Fig. 2 and
3.

Thus, we should be able to learn that the soy-
bean, especially of autumn soybean type or of
late flowering, is planted well at such a time
as to bear abundant flowers in comparatively
short duration, and that the fact is due to the
seasonal change of natural day length affecting
the flowering process after the flower primordia
initiation. Accordingly the adaptation of soy-
beans, especially of autumn soybean type, to-
Fig. 2. Relation between the growing stages of autumn soybean type, Akazaya-shirodaizu, planted at successive times and seasonal change of day length. (at Sasayama, Hyogo, 35° 4'N)
Remarks: s; sown, e; emerged, f.p.; flower primordia initiated, b.f., e.f.; beginning and end of flowering, m; maturity

Fig. 3. Interrelations between the days to flowering or the duration of flowering and the day length as varied by planting time—I; April 10, II; July 25 in half month interval.

planting time has to be considered primarily as the phenological response due to the variation of day length above all factors.

In Japan, it is believed by farmers and some of agronomists that decrease in yield of autumn soybean type by early planting is capable of being recovered by such cultural practices as transplanting, pinching the top, spaced planting and a good management of fertilizers. It is also said that a farmer had got high yield of autumn soybean planted early by applying some of the said practices. The results of these studies, however, emphasize that adaptable time of planting is obligatory factor determining the seed yield of autumn soybean type in Japan, and then the practices mentioned above is not so effective as to cover the yield decreased by early planting, as described in the introduction of this paper.

Literature cited
【和文摘要】

大豆型対大豆型の春花結実に関する研究

第5報 大豆型の花芽分化後の日長の影響と播種適期について*

尾田 忠男
（兵庫農科大学）

前報までに、播種期による収量変化をともに関係のある春花の長さ、とくに開花期の長短、日当開花数の多少には、栽培密度、播種、移殖、2,3,5-T 撒布、施肥等の栽培的処置が著しい影響を及ぼさないことを報告した。

本実験では、大豆型赤花白大豆を用い、4〜5月の早期に播種し、開花前17日、開花5日、開花後10日（1955年）より9時間の短日を施し、次の結果を得た。（1）花芽分化後の短日は開花期間を著しく短縮し、日当開花数を増加する。（2）その効果は、開花前7日から開花後に処理を開始したものに顕著であるが、処理開始の早晚いずれにせよ著しい影響は見られなかった。

この結果と第2報の播種期試験の結果を比較すると、標準区及び開花後10日よりの処理区は4〜5月の早期播種に、開花前17日よりの処理区は7月以降の晚期播種に相当し、開花前10日〜開花後処理区は6月の適期播種に近似する。このことは大豆、とくに大豆型品種の播種適期を左右する要因として、従来述べられてきた花芽分化期及び開花期に及ぼす日長の影響よりも、むしろ開花期後の開花期間及び日当開花数に及ぼす日長、すなわち花芽分化期後の日長の影響が重視されればならぬことを示すものと言えよう。従って、大豆型を早期播種した場合、開花期に伴う茎葉の繁栄を抑制するために上記栽培的処置を行うことは、豆収防止上大きな効果を期待することができない。大豆型大豆には適期播種がもっとも肝要であることを確認すべきである。

* 昭和33年4月9日 第119回講演会に於て発表