Research Notes : China : Studies on genetic variation of soybean agronomic characters induced by seed irradiation

Zhihong He

Soybean Research Institute of HAAS

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1) Studies on genetic variation of soybean agronomic characters induced by 
seed irradiation.

Since the 1950s, there have been a lot of geneticists who studied the 
 genetic variation of the populations derived from irradiated seeds in the 
world, but only a few who studied the principle of selection for these popu-
lations. Some breeders have not only developed new varieties by using irra-
diation, but also have studied the genetic variation of irradiated popula-
tions. However, the populations that they used had been often selected; 
therefore, it was hard to avoid that the results had been influenced by di-
rectional selection effect. The purpose of this work was to study the vari-
ation, heritability, and genetic advance of major agronomic characters in M2 
and M3 by using random sampling populations derived from seed irradiation 
in order to know the genetic variation regularity of major agronomic charac-
ters of soybeans and try to find out the best suitable generation and focal 
point of the characters for selection in irradiated populations.

Materials and methods: The experiment was laid out consecutively for 
three years, 1979-1981, in nested design with four replications. Dry seeds 
of three soybean varieties were irradiated by 60Co-γ ray with a dosage of 
16KR. The varieties irradiated were 'Fengshou 10', 'Dongnong 74-403', and 
'Heinong 26', and nonirradiated seeds of the corresponding varieties were 
used as control. Three types of plants, semi-stereile (MS), fertile (MF) and 
control (CK), were harvested randomly in M1 to derive M2 and M3 populations. 
Ten plots were harvested for each type in 1979 (M1); 30 lines were planted 
in 1980 (M2); then, half of those lines was planted to get M3 family popula-
tions. There were five lines for each family, five families for each type 
population, and three type populations (MF, MS, and CK) in 1981 (M3).

The genotypic variance was estimated by using variance of CK as environ-
mental variance and the variance of MF and MS populations as phenotypic vari-
ances. On this basis, the broad sense heritability was estimated. The 
genetic advances expected through selection and relative genetic advance 
were estimated as described by Robinson et al. (1961) and Johnson et al. 
(1963), respectively.

Results and analyses: 1. The frequency distribution curve of every 
agronomic character in irradiation populations was more expansive than those 
of CK. It showed that after irradiation new variances of major agronomic 
characters occurred in the irradiated populations. The characters that show 
a higher level of genetic variance were number of branches, seeds per plant, 
pods per plant, and yield of plant, GVC=20-30%. Seed weight and ratio be-
tween seed and stem weight were middle in the level of genetic variance, 
GVC=10-20%. The characters with the lowest level of genetic variance were 
plant height, number of nodes of main stem, and growing date, GVC<10%. The 
result of M3 was similar to those of M2, but the frequency of variance was 
somewhat lower.
2. In M2, the characters with high levels of heritability were growing date and 100-seed weight. The value of their heritabilities was about 80%. The characters with middle level of heritability, about 60%, were pods per plant and nodes of main stem. The characters with lower level of heritability, less than 40%, were plant height, branch, seed per plant, ratio between seed and stem weight, and yield per plant. In M3, the heritability of ratio between seed and stem weight was second when it was estimated by using lines as the unit, and that of plant height was second when estimated heritabilities by using the correlation between M2 and M3.

3. Some selection advance for every character could be obtained when the selection had been carried out as a selection ratio with 5% in irradiated populations; that was more than 30% for branch, seeds per plant, pods per plant, yield per plant, and 100-seed weight; that was around 20% for ratio between seed and stem weight, plant height and nodes of main stem. The relative genetic advance of growing date was the lowest. It was less than 10% (see Figure 1).

4. In M2, it was effect that characters of growing date and seed weight, which heritabilities were higher, had been selected. The actual gain was about 25% of that of expected value, and the selected effect to get early maturing and big seeds was higher than that to get late maturing and small seeds. But, it was not effect that selection had been carried out for yield of plant with lower level of heritability. The actual gain was only one-thirtieth of expected value (see Table 1).

5. There was no immediate relationship between M1 and M2 in fertility and major agronomic characters. When the normal plants of M2, which derived from semisterile plants, were planted, all of the plants of M3 were normal in fertility. Performances of major agronomic characters showed similar as that of the progenies which came from normal plants of M1.

Discussion: 1. Under irradiation treatments, all nine agronomic characters performed definite genetic variation. The estimates of the phenotypic variance of irradiated plants averaged two times as large as those of controls. The variations were heritable. Genetic advance expected through selection can be obtained when selection was exerted upon the irradiated populations. The magnitude of estimates of heritability of all the characters in the M3 became smaller in comparison with those of M2, and such characters tended to become stable in M3.

2. M2 is the crucial generation for selection, because irradiated populations varied more extensively and thus had greater potential for selection. Some characters had larger heritability value in M2, and their correlation values between M2 and M3 were also significant.

3. Selection may be taken for growing date, 100-seed weight, and plant height in M2, because they had larger heritability in that generation, and correlation between M2 and M3 was significant. The performance of these characters in M2 may be represented in M3. In M3 reliable selection can also be taken for ratio between seed and stem weight. Selection for other characters seems not to be justified before M3.
4. The value of all the genetic parameters of the progenies of MS were bigger than those of MF. More extensive variability, greater heritability and greater genetic advance expected through selection were obtained from progenies of MS. Most plants of the progenies of MS in M1 can recover to normal fertility in the future generations. Plants of MS in M1 are more valuable for mutation breeding.

<table>
<thead>
<tr>
<th>Genetic Advance %</th>
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<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>401</td>
<td>B</td>
</tr>
<tr>
<td>301</td>
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<tr>
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<td>W</td>
</tr>
<tr>
<td>80</td>
<td>Y</td>
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</table>

<table>
<thead>
<tr>
<th>Character</th>
<th>Variety</th>
<th>Heritab. in M2</th>
<th>Direction selected</th>
<th>Gain through selection</th>
<th>Actual gain in M2</th>
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<tbody>
<tr>
<td>Growing date</td>
<td>Fengshou 10</td>
<td>84.44</td>
<td>Early maturity</td>
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<td>3.0</td>
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<td>100-seed weight</td>
<td>Fengshou 10</td>
<td>81.96</td>
<td>Big seed</td>
<td>10.4</td>
<td>2.6</td>
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<td>Plant yield</td>
<td>Dongnong</td>
<td>24.10</td>
<td>High yield</td>
<td>48.1</td>
<td>0.4</td>
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</table>

Figure 1. Relative genetic advance of irradiated population

Table 1. Effect of selection on several main agronomic characters in M2
References


He Zhihong
Soybean Research Institute of HAAS, CPR