Soybean breeding at the Institute of Field and Vegetable Crops

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Abstract: At the Institute of Field and Vegetable Crops in Novi Sad, single seed descent method has been used successfully for more than twenty years resulting in 110 varieties registered in Serbia and 54 abroad. Soybean selection has so far focused on the increase of yield, yield stability and developing varieties adaptable to different growing conditions. Italso takes into account the customerspreferences and the processing industry. This is reflected most notably in our work on increasing and balancing oil and protein content.Recent investigations are aimed to further improvement of nutritional and medicinal properties by researching the activity of secondary metabolites, particularly isoflavone and phytoestrogene.

Key words: breeding, soybean, *Glycine max*, protein, secondary metabolites, yield

Soybean (*Glycine max* (L.) Merr.) breeding, as well as growing, has not a long tradition in Serbia, in spite of favorable agroecological conditions, and soybeans took significant acreage in Serbia not before the mid-1970s. Since successful crop production and management of problems associated with crop growing cannot be carried out without the support of good and versatile research work, Soybean Department has been founded at the Institute of Field and Vegetable Crops in Novi Sad. Researchers at than newly founded department carried out work on identifying and resolving problems occurring in the cultivation of soy. The soybean breeders faced the most important, and the most demanding challenge – to create the first domestic soybean varieties that will have high yielding genetic potential and be well adapted for the domestic growing conditions.

Soybean breeding, like breeding of other crops, is a process involving the development of variability for desired traits, identification of superior genotypes and multiplication of their seed for commercial production. Variability is obtained by crossing parents that possess specific traits intended for transfer into new or improved varieties. Progenies of these crosses segregate genetically in the course of successive generations of selfing and new genotypes are thus formed. Various selection methods are used for identification of those progenies which possess the most useful combinations of the desired traits. The choice of the selection method depends on breeding objective as well as on other important factors such as the available variability, availability of agricultural machines and greenhouse, size and skill of breeding team, etc. In its turn, breeding objective depends on the local agroecological conditions, available acreage, intensity of production, market demand and the economy of production. At the beginning of work on soybean breeding at the Institute of Field and Vegetable Crops, pedigree selection method was chosen. But it was soon replaced by the single seed descent method (SSD), method that has been used successfully and most often in soybean breeding worldwide (21).

The single seed descent method was proposed by Brim (1) and the procedure has been the predominant method of soybean selection in the U.S. since. Single seed descent makes it possible to produce three generations of self-pollination in a single year using winter nurseries or greenhouses, thus accelerating the development of homozygous lines for the testing of yield in replicated trials. However, due to the unavailability of a winter nursery and a lack of sufficient greenhouse space that would accommodate all of the breeding materials, breeders at the Institute has had to adapt the method to make it suitable for such conditions and is making use of only those aspects that involve the reduction of space and labor while at the same time maintaining a satisfactory level of variability up to the F5 generation (20).

The single seed descent method is usually not applied until a certain level of homozygosity is reached in the F_4 or F_5 generation. Selection in the earlier generations can still be done, but on a smaller scale, i.e. it is performed in the sense that pods are not taken from plants that are diseased or lodged or prone to pod splitting and so on (Fig.1) .

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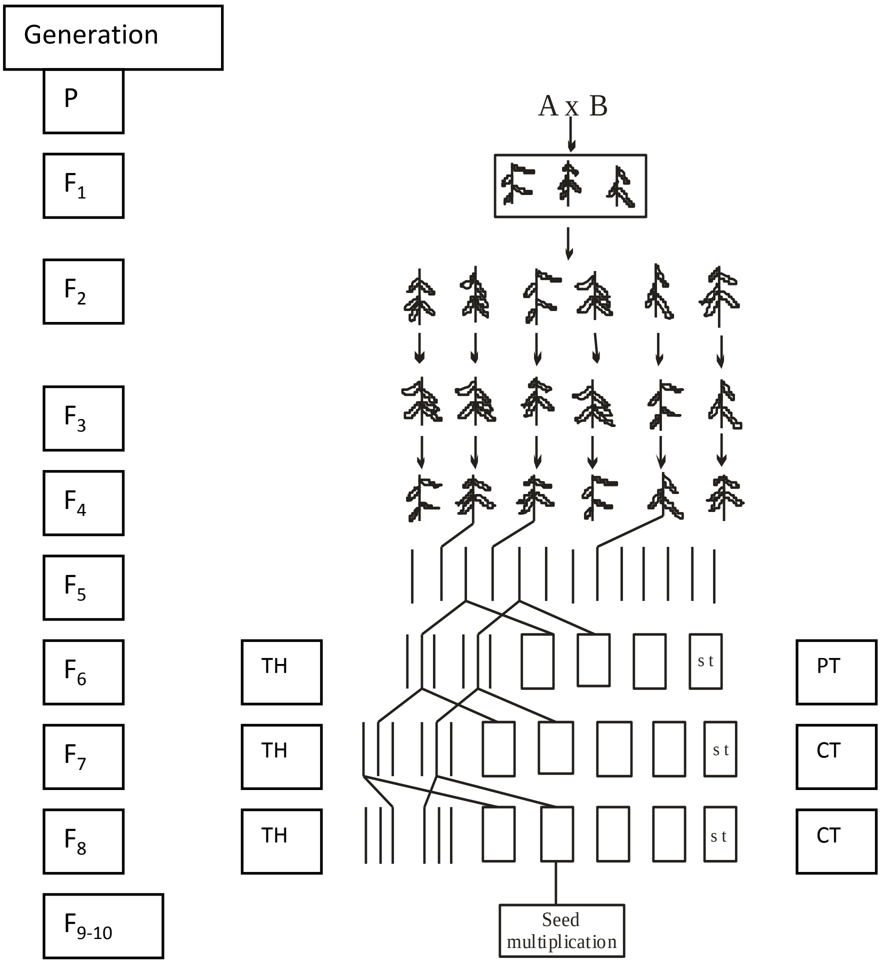

Figure 1. Single Seed Descent Method

Single seed descent requires that only the most basic data be taken down, such as the designation of the cross and what generation it is in. Also, minimal space is required to grow successive generations of individual plants when compared to the rows of progenies characteristic of pedigree selection. Another advantage of the single seed descent method is the presence of full variability in each generation. With no selection in the early generations, the amount of variability present among the F_5 plants is similar to that found in the F_2 generation. Finally, the number of recessive homozygotes increases in successive generations – with the postponement of selection for a recessive trait until the F_5 generation, nearly 47% of the plants will be homozygous for such a trait (25).

It is obvious that the soybean breeding is a complex and difficult task that takes a long time. It takes six years for a genotype to progress from the initial cross to a line that can be considered pure (F_5). Another three years are needed for preliminary and comparative trials. Then, even if no multi-site or large-plot trials are carried out, three more years are needed for the official variety trials. Therefore, it takes a minimum of 12 years for a soybean variety to be developed. Of course, testing can also be done in the early phase of breeding and it is still perfectly possible for an insufficiently tested variety to be put through the official trials and even outperform the standard variety.

At the Institute of Field and Vegetable Crops in Novi Sad, SSD method of selection has been used successfully for more than twenty years, and it resulted with 110 varieties registered in home country, and 54 in other European and Asian countries. Soybean selection at the Institute has so far focused the most on the increase of yield and yield stability (14, 16, 17) and on developing varieties adaptable to different growing conditions (4, 18, 19). However, the Institute's soybean program also makes sure to take into account the preferences of its customers and the processing industry and to adapt to the demands of the market. This is reflected most notably in our work on increasing and balancing oil and protein content of our varietis by conducting studies in field and laboratory conditions. In spite of its high heritability, the major difficulty in breeding programs for increased protein content of soybean seed has been the usually negative genetic correlations between seed protein and seed yield as well as the high negative correlations between seed protein and seed oil (12). In human nutrition, the ratio between oil and protein in the soybeans is important as well, for obtaining a high-quality final product. Improvement in chemical composition of soybean grain could be achieved by increasing both protein and oil content on the account of carbohydrates. Carbohydrates are not abundant in soybean grains but can be a limiting factor in the nutrition of certain animals. The amount of stachyose and raffinose in soybeans and products limits the digestibility and usability of soybean oil and protein in nonruminants. Breeding for grain carbohydrate composition is aimed at reducing the levels of stachyose and raffinose and increasing the sucrose content of soybean grain. Breeding programs on this are still in the early stages, so it is too early to talk about their results.

In addition to this, the balance between the levels of oligosaccharides and polysaccharides for the purposes of fish food production were studied (4, 24), as well as problems regarding nitrogen metabolism (5, 6, 13), and the antioxidative properties of soybean (7, 8, 9, 10, 11), which should furher emphasize the importance of soybean in human diet.

Recent investigations are aimed to further improvement of nutritional and medicinal properties of soybeans by researching the activity of secondary metabolites, particularly isoflavone and phytoestrogene (2, 3, 22, 23). Enriched isoflavone and phytoestrogene composition is not important just in direct use of soybean as a food, but even more in its use as a feedstock for pharmaceutical products. ■

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