Problems of rational varietal placement of soybean in the Amur region

O A Selikhova* and P V Tikhonchuk

Far Eastern State Agrarian University, 86, Politeknicheskaya Street, Blagoveschensk, 675005, Russia

*E-mail: olgacoa@bk.ru

Abstract. The article presents an analysis of seven-year data on varietal placement of soybean in the fields of the Amur Region. The share of soybean varieties of Amur and foreign breeding and non-varietal part of seeds is shown. Emphasis is placed on the problems of not rational varietal placement of soybean. The most popular breeding varieties of All-Russian Scientific Research Institute of Soybean for the last two years have been noted: Alena, Gratsiya, Dauriya, Lidiya, Nega 1, Umka. In the Amur Region, the share of soybean varieties of early-ripening group in the total sowing is 31.1%, mid-ripening – 49.6% and late-ripening – 7.6%. In most farms, a set of varieties of different groups in precocity does not correspond to hydrothermal conditions and economic opportunities. At the same time, 12-18% of soybean seeds sown in the fields of the Amur Region are not varietal. Recommendations for the rational management of soybean farming are formulated: apply varieties corresponding to the climatic and economic capabilities of the region; improve the structure of crops, where the share of soybean should not exceed more than 60%; master scientifically based crop rotation regimes providing maximum output product per unit area with preserving soil fertility; sow seeds not lower than the third reproduction; to select a set of varieties of various groups according to their precocity corresponding to hydrothermal conditions and economic potential; improve soybean seed production in the region to provide high-quality and affordable seed material to all farms.

Soybean is one of the priority and highly profitable crops in the Amur region. The Amur Region has been a leader for many years in terms of sown area and soybean production in Russia. In 2019 the sown area under soybean in the region amounted to 28% of the total Russian volume and 63% of the volume in the Far Eastern Federal District. This is due to natural historical and economic factors, the presence of sufficiently fertile soils and relatively favorable hydrothermal regime in the agricultural districts of the region. First breeding works on soybean in Russia began in 1915-1917 on the Amur experimental field. The beginning of the mass introduction and distribution of soybeans in Russia is 1924-1927 [1,2]. In recent years, due to the expansion of soybean crops in other regions of the Russian Federation the proportion of soybean in the Amur region has been reduced as compared with 2018 by 5%.

High current profitability of soybean stimulates agricultural producers to allot more land in the Amur Region to soybeans crops, however, the possibilities of an extensive way of expansion volume are limited.

The limiting factors of soybean sowing in the Amur Region is a short frost-free period, not high sum of active temperatures, long daylight hours, slow heating of the soil in the spring, uneven...
distribution of precipitation during the growing season (lack of moisture in April-June, monsoon rains in the second half of summer and an excess of rainfall in July-August, causing overwetting). According to the thermal conditions of the growing season, the region is divided into five agro-climatic regions. The first district is the warmest, occupies the southern part of the region; the sum of active temperatures in it is more than 2200 °C. The second region is warm, has a sum of temperatures of 2200-2000 °C. The third is moderately warm, the sum of temperatures here is 2000-1800 °C. The fourth is moderately cool, the sum of the temperatures in it is 1800-1600 °C. The fifth district is cool with the sum of temperatures below 1600 °C. Three subareas are distinguished depending on the varying degrees of moisturizing: moderately humid – hydrothermal coefficient (HTC) is 1.6; humid–HTC 1.6-2.0; excessively humid – HTC more than 2.0 [3, 4, 5].

According to hydrothermal conditions, the Amur Region is divided into three zones of soybean sowing: southern, central and northern [6].

The listed factors are not governed by agricultural practices. Therefore, the sort is one of the main means of agricultural production. If the main factors affecting the size of the crop are arranged in the order of their importance, then the first place belongs to the sort, the second – to fertilizers, the third – to measures for the care of crops and their protection from diseases, pests, weeds [4]. It is quite natural, since all agrotechnical measures are aimed at maximally revealing the genetic possibility of the variety. Introduction of correctly selected soybean varieties into production, with considering biological features, soil and climatic conditions of the farm allows to increase the economic efficiency of production. High-yielding varieties, which, under local conditions, have the most valuable biological and economic properties, are the main element of any crop cultivation technology [7, 8, 9, 10].

The varietal composition of soybean is annually replenished new varieties. So in 2014 16 varieties of local (Amur), Russian and foreign breeding were cultivated in the farms of the region, in 2015 there were already 25, in 2016 – 32, 2017 – 34, in 2018 – 36 and in 2019 – 45 varieties. In the Amur Region, most of the crops are occupied by soybean varieties of the FSBSI All-Russian Scientific Research Institute of Soybean and this is more than 50% of the sown seeds of the total. In 2014 and 2015 57% of soybean varieties of breeding of All-Russian Scientific Research Institute of Soybean were sown stably. An increase of 4% was observed in 2016, the share of sown varieties amounted to 61.6%. However, since 2017, an increase in the share of soybean varieties of foreign origin breeding of Canada (Alyaska, Asuka, Amadeus, Kassidi, Kioto, Kofu, Maksus, OAK Prudens, Opus, Siberia, Terek) and Belarus (Volma, Oressa, Pripyat) was noted (table 1). The most popular varieties of breeding of All-Russian Scientific Research Institute of Soybean for the last two years: Alena, Gratsiya, Dauriya, Gratsiya, Nega 1, Umka.

It is known that it is not recommended to sow seeds below the third reproduction, which is directly related to the crop. The lower the reproduction, the lower the yield of the variety. At the same time, sowing of seeds with IV-VII reproductions is carried out annually.

Popular varieties lose their position in crops due to the fact that they are sown with less quality seeds, which entails a decrease in yield. And as a result, agronomists choose varieties of foreign selection in which the seeds of I-III reproductions.

When evaluating soybean varieties, special attention is paid to such economically important indicators as productivity, duration of the period of vegetation and its individual phases, plant height and attachment of lower beans, cracking of beans during ripening, seed damage during harvesting, as well as protein and fat content in seeds.

The duration of the period of vegetation is one of the main indicators of the soybean variety, which determines the possibility of its cultivation in certain ecological conditions. Currently, more than 40 soybean varieties are cultivated in the region, which, according to the production classification, are divided into 4 groups according to their early-ripening [3]:

1. Ultra-early-ripening – 90 and less days.
2. Early-ripening – 91-102 days.
3. Mid-ripening – 103-114 days.
4. Late-ripening – 115 and more days.

**Table 1.** The share of non-varietal soybean seeds in crops of the Amur region.

| Origin of the variety | 2014  | 2015  | 2016  | 2017  | 2018  | 2019  |
|-----------------------|-------|-------|-------|-------|-------|-------|
|                       | tons  | %     | tons  | %     | tons  | %     | tons  | %     | tons  | %     |
| All-Russian Scientific Research Institute of Soybean | 41884 | 57.4  | 50258 | 57.7  | 65128 | 61.6  | 68070 | 59.0  | 61804 | 52.3  | 53580 | 53.0  |
| Krasnodar             | 0     | 0.0   | 0     | 0.00  | 15    | <0.1  | 220   | 0.2   | 844   | 0.7   | 831   | 0.8   |
| Far Eastern Research Institute of Agriculture | 328   | 0.5   | 348   | 0.40  | 500   | 0.5   | 520   | 0.5   | 790   | 0.7   | 1176  | 1.1   |
| Far Eastern State Agricultural University Scientific Research Institute of Agriculture of the South-East | 1866  | 2.6   | 1521  | 1.6   | 352   | 0.3   | 0     | 0.0   | 0     | 0.0   | 0     | 0.0   |
| Belarus               | 0     | 0.0   | 23    | 0.03  | 377   | 0.4   | 2023  | 1.8   | 3051  | 2.6   | 3991  | 3.9   |
| Austria               | 882   | 1.2   | 1638  | 1.9   | 332   | 0.3   | 145   | 0.1   | 571   | 0.4   | 2103  | 2.0   |
| Canada                | 235   | 0.3   | 559   | 0.64  | 2061  | 1.9   | 6777  | 5.9   | 17231 | 14.5  | 19857 | 19.0  |
| Other                 | 4     | <0.1  | 119   | 0.1   | 225   | 0.2   | 2150  | 1.9   | 5     | <0.1  | 5     | <0.1  |
| Not varietal          | 11064 | 15.1  | 15870 | 18.21 | 16313 | 15.4  | 14161 | 12.2  | 16813 | 14.2  | 12129 | 12.0  |
| Not verified          | 10168 | 13.9  | 10216 | 11.71 | 13736 | 13.0  | 14817 | 12.8  | 12762 | 10.8  | 7970  | 7.8   |
| Total for the region  | 72949 | 100   | 87161 | 100   | 105674| 100   | 115292| 100   | 118195| 100   | 100955| 100   |

In the Amur Region, the share of soybean varieties of early ripening group in the total sowing is 31.1%, mid-ripening – 49.6% and late-ripening – 7.6%. It is believed that such a ratio between varieties that differ in the duration of the plantlet-ripening period can be considered close to optimal. However, in most farms, a set of varieties of different groups in their early ripening does not correspond to hydrothermal conditions and economic opportunities. Wherein, 12-18% of soybean seeds sown in the fields of the Amur Region are not varietal (figure 1).

With the goal of efficient soybean production in each farm it is advisable to grow at least two soybean varieties and in the farms of the southern zone of three varieties that differ in early-ripening. Choose late-ripening soybean varieties, with a period of vegetation of more than 120 days is necessary with extreme caution, since even in the southern zone, with the exception of individual microzones, they do not have enough heat to ripen.

Therefore, if on the territory of the farm the sum of active temperatures less than 1680 °C, varieties with period of vegetation less than 90 days should be chosen. If there is a sum of temperatures of 1780-1950 °C, it is better to cultivate ultra-early-ripening and early-ripening varieties; when providing heat at the level of 1900-2200 °C it is advisable to sow mid-ripening and early-ripening varieties and with a sum of temperatures of 2200-2300 °C, it is desirable to have a set of varieties different ripeness groups.
Thus, in the southern zone of the region in modern conditions, early-ripening varieties should occupy 10-15%, mid-ripening 60-70% and late-ripening (up to 120 days) 15-20%. In the central zone, the share of early-ripening varieties increases to 20-30%, and mid-ripening decreases to 40-50%, in the northern zone, ultra-early-ripening and early-ripening varieties should be sown.

Figure 1. The share of non-varietal part of seeds in soybean crops of the Amur region.

The growth of sown areas under soybean in the region occurs not only due to the plowing of fallow lands, but also due to the uncontrolled growth of its crops in the structure of crop rotation and reduction of crops of other crops. Changes in the structure of sown areas in favor of soy are due to the high profitability of this crop. The selling price for soybean, growing at a faster rate than the cost of cultivating it, makes it possible to ensure production profitability of up to 60% [11]. Disproportions in the structure of sowing of crops towards prevailing of soybean contribute to the deterioration of soil fertility and phytosanitary conditions (increase in crop weediness, disease of soybean and the spread of pests) and, as a result, reduced yields. In addition, many farms cultivate soybean continuously for 2–4 years in a row.

With an increase in sown areas under soybean and an increase its gross harvests, the dynamics of soybean productivity is very unstable: in 2019 the yield amounted to 1.3 t/ha, however, the 2011 level has not been reached.

Thus, for the stable operation of the crop production industry, in particular soybean farming in the region, it is necessary:
- apply varieties corresponding to the climatic and economic capabilities of the region;
- improve the structure of crops, where the share of soybean should not exceed more than 50-60%;
- master scientifically based crop rotation regimes providing maximum output product per unit area with preserving soil fertility;
- sow seeds not lower than the third reproduction;
- to select a set of varieties of various groups according to their precocity corresponding to hydrothermal conditions and economic potential;
- improve soybean seed production in the region to provide high-quality and affordable seed material to all farms.
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