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## Characteristics of Productivity Formation of Common Bean Variety Accessions in the Dry-Steppe Zone of Chestnut Soils in the Lower Volga Region

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**Abstract**—Productivity of various common bean variety accessions is studied. It is shown that, under favorable conditions, domestic varieties Oka and Gornal' can provide a seed yield up to 1.4 t/ha with a high protein content, 23.4 and 22.8%.

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The common bean has not become widespread in the Volgograd oblast, although it surpasses other pulses in nutritional and taste qualities. The main reason for this is the absence of harvestable varieties (owing to the low attachment of the pods, yield losses during combine harvesting amount to 50–70%), undeveloped planting rates, times, and methods, and weediness of the fields. The first farm-scale bean plantings in the oblast, carried out in the Svetlyi Yar, Gorodishche, and Mikhailovka districts on irrigated lands, produced more than 2 t seeds/ha.

To obtain high-quality ecologically safe dietary food products from beans, it is necessary to select high-yielding varieties most valuable nutritionally. These investigations were carried out on the grounds of the experimental field of the Lower Volga Agricultural Research Institute.

### METHODS

The climate in the region of conducting the experiments is markedly continental with frequent droughts. The hydrothermal coefficient is 0.6, cumulative positive air temperatures 3459°C, and average annual precipitation about 300–350 mm. The soils of the section are heavy loam (up to 25% solonetz) and contain 1.8–2% humus. The investigations were conducted on black fallow, management of which was done in accordance with the recommendations for the dry-steppe zone of chestnut soils: in the spring, tandem disk harrowing with zig-zag harrows, early spring cultivation to a depth of 8–10 cm, preplanting cultivation to 5–6 cm with simultaneous harrowing, planting with an SO-4.2 planter after warming of the soil to 10–12°C, wide-row planting method with 70 cm between rows and post-planting roller packing. Replication was fourfold, the area of the plots was 126 m<sup>2</sup>. During growth interrow weeding was done manually twice in individual years.

Twelve bean varieties bred in Ukraine, Russia, and USA were tested (Table 1).

The main stages of plant development were observed, and the density of their stand after sprouting and before harvesting, soil moisture in the 0–1-m layer, nutritive regime, structure, yield, and quality of the seeds were studied.

Favorable meteorological conditions developed in the first year of the investigations. Planting was done on moist soil and soil moisture storage was optimal, which caused good seed germination (85–90%). An average daily temperature during growth of 25°C and precipitation amount of 22.6 mm had a positive effect on growth and development of the plant, and length of the growing season. In the second year, the average daily temperature in the planting–sprouting stage was 16.3°C and the precipitation amount was 86 mm, which provided uniform sprouts and subsequent survival of the plants up to harvesting; in the flowering–bean formation stage, respectively 21.7°C and 38.6 mm. The third year was characterized by dry weather conditions. In the planting–sprouting stage, the average air temperature was 19.9°C, there was no precipitation, and in the flowering–bean formation stage, respectively 29°C and precipitation 36.7 mm.

### RESULTS AND DISCUSSION

During the 3-year investigation, survival of bean plants depended strongly on the meteorological conditions: it decreased 1–9% in most varieties in the unfavorable dry year. On average its value was mainly the same, greater in varieties Pink and Pyatnistaya and less in varieties Gornal' and Morskaya (Table 1).

The moisture content under the bean crops affected the yield. Thus, the first year was the most favorable with respect to the water balance for plants; they consumed 318 mm of moisture, in the second year 196.3 mm, and in the third 195.5 mm.

**Table 1.** Germination and survival of bean plants of various variety accessions

Variety	Year of investigations									Average survival, %
	first			second			third			
	number of, per m <sup>2</sup>		survival, %	number of, per m <sup>2</sup>		survival, %	number of, per m <sup>2</sup>		survival, %	
	sprouts	plants by harvesting		sprouts	plants by harvesting		sprouts	plants by harvesting		
Pervomaiskaya (Ukraine)	23	21	91	24	22	91.6	21	18	85.0	89.2
Gornal'	24	21	87	13	11	84.0	24	21	87.0	86.0
White (USA)	–	–	–	–	–	–	29	26	89.0	89.0
Nerussa	25	23	92	30	27	90.0	30	25	83.0	88.3
Large Northern (USA)	25	24	96	24	22	91.6	24	21	87.0	91.5
Oka	32	30	93	18	16	88.9	20	18	90.0	90.6
Morskaya	22	20	90	15	13	80.7	30	28	93.0	87.6
L 243/82	22	21	95	15	13	86.7	23	21	91.0	90.0
Dark Red (USA)	–	–	–	–	–	–	24	22	91.0	91.0
Pink (USA)	33	32	96	37	36	97.3	31	27	87.0	93.4
Rubin	31	30	96	25	23	92.0	21	20	95.0	94.3
Black	30	28	93	25	22	88.0	25	23	92.0	91.0
Average for varieties	27	25	92.5	23	20	87.0	25	22	88.0	–

At the start of growth the content of nitrogen in the soil was 32.9 mg/kg, phosphorus 37.6 mg/kg, and potassium 502 mg/kg, and by the end of growth it was respectively 31.0, 28.0, and 514 mg/kg.

On average during the three years, the protein content in the bean seeds was from 21.1% for variety Pink to 28.62% for variety White, in the other varieties it was 22.5–23.1%; the content of fat was 1.4–2.5%, starch 26.1% (Pervomaiskaya) and 31.9% (Rubin), and a

smaller amount was found in variety accession White 15.6% and Morskaya 19.7%.

During the 3-year investigation, the maximum bean yield was noted in variety Pink and the minimum in varieties Nerussa, Dark Red, and no. 243/82 (Table 2). The variety accessions Pervomaiskaya, Pink, and Morskaya and the domestic varieties Gornal', Rubin, Nerussa, and Oka provided the greatest amount of protein (Table 2). In the year especially favorable for growth and development of beans, the protein harvest was 450–490 kg/ha.

Consequently, under conditions of the light-chestnut soils of the right-bank region of the Volga and on black fallows, it is possible to produce up to 1.0–1.3 t/ha beans and in favorable years up to 2.0–2.6 t/ha. The white-seeded domestic bean varieties Oka and Gornal' are able to provide a seed yield up to 1.4 t/ha with a high protein content in the seeds, 23.4 and 22.8%, which means a protein harvest of 198 and 149 kg/ha.

**Table 2.** Yield and protein harvest per hectare on average during years of investigations

Variety	Yield, tons/ha	Protein harvest, kg/ha
Pervomaiskaya	1.0	207
Gornal'	0.7	149
White	0.3	86
Nerussa	0.5	104
Large Northern		
Oka	0.9	198
Morskaya	0.6	132
L 243/82	0.5	108
Dark Red	0.5	114
Pink	1.3	254
Rubin	1.2	238
Black	0.9	197
LSD <sub>0.5</sub>	0.8	169

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