ORIGINAL ARTICLE

Features of morphology and biology of broad bean samples in the south of the central black earth region (Russia)

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Abstract

Background and Objective: Studied morphobiological features of collection varieties of broad beans in the conditions of the South of the Central Black Earth Region (Russia): The duration of the growing season; level seed production and its components; biochemical composition of seeds; structure of microbial interactions in the rhizosphere; and relation to pathogens. **Materials and Methods:** In field experiments 2014-2016, the first reproduction seeds of 24 varieties, were cultivated according to the requirements of the zonal farming. It was revealed early-maturing, high-yielding varieties with large seeds, and high protein. Were determined the parameters of a promising variety of broad beans and were revealed indirect signs of high-protein and productivity when working with initial material. On average, the vegetation period of broad bean lasted 89 days. The duration of the periods before the seedling and after flowering was highly correlated with the duration of the vegetation period (r = +0.61 and r = +0.87, respectively). The seed weight per plant was significantly correlated with the number of bean per plant (r = +0.8) and the number of pods on the lateral stem (r = +0.68). **Results:** The averaged correlation was observed for the seed weight per plant and the number of producing lateral stem (r = +0.42), the number of productive nodes of the main stem (r = +0.54), the number of inflorescences per plant (r = +0.36), number of inflorescences of lateral stem (r = +0.39). The number of seeds per pod was negatively correlated with the number of pods per plant (r = −0.46). The pod size was negatively correlated with the number of bean per plant (r = −0.54). Protein content of the broad bean seeds is 18-33%. An indirect indicator of the high protein content of the seeds can be served as "the number of nodes on the main stem" with the inverse relationship (r = −0.4) and "the weight of 1000 seeds" with a positive relationship (r = +0.7). **Conclusion:** The study of the initial material of broad beans in the soil and climatic conditions of the Belgorod region made it possible to identify a group of early ripening, with the fastest formation of pods.

Key words: Broad beans, earliness, high protein seeds, indirect signs of productivity, model of promising varieties, seeds productivity, soil improvement

INTRODUCTION

Broad beans (*Vicia faba* L. var. major Harz) have found wide application in the national economy and medicine. Hence, their green pods, seeds, and young leaves are used for food in fresh, cooked, dry, frozen, and canned, so they are a valuable food crop. The protein of beans by amino acid composition most closely approaches the animal and is capable of replacing it. Seeds and plants contain carbohydrates, Vitamins A, B_1, B_2, C, PP, organic acids, mineral salts of potassium, phosphorus, calcium, and magnesium, the taste, and caloric content of beans is not inferior to other vegetables. Therefore, beans have a great potential and should take the leading place in the development of third generation food technologies, which are processed in terms of chemical composition and biological value.[1,2]

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However, in Russia so far there are no varieties that are maximally adapted to cultivation in local conditions. The idea of an "ideal variety" has been repeatedly expressed, but it has not yet been realized. When creating new varieties and improving existing ones, much attention is paid to the study of the source material, as the basis for the selection of any plants.[3,4] Therefore, the purpose of our research was to study of the morphological and biological characteristics of samples of broad beans in the conditions of the south of the Central Black Earth Region.

MATERIALS AND METHODS

The research was carried out on the basis of the Botanical Garden (Belgorod). There are 20 varieties of broad beans were studied in small-scale experiments (Aquadul, Batrom, Belorusskiye K-1404, white large-fruited, white pearl, Bobchinsky, Velena K-2267, Windsor, Dachnik, Children's delight, Green Jack, Gourmet dish, Karmazin, Leader, Optics, Pink flamingos, Russian blacks Three times white, Tsar's harvest, Yankel bialy) and 4 hybrids (Bel-1, Bel-2, hybrid, VN-34).

The soil in the experimental plot is ordinary chernozem, the granulometric composition is medium loam (containing up to 30-45% of physical clay), structurally small-lumpy, with an active acidity of 7.6. The agrotechnical measures were carried out manually according to the requirements of zonal agrotechnics. The growing season of vegetable beans in 2014 was different at once in 2 dry months - March-April, when the main reserve of moisture in the soil is created for successful initial stages of organogenesis of beans, and July, the period of active flowering and fruit formation. In 2015, a lack of precipitation is noted throughout the growing season. In 2016, after a very wet May (the period of active vegetative growth of plants), dry June (active development of generative organs) occurred.

For conventional observations, conventional methods were used.[5,6] Evaluation of seed productivity of plants was carried out according to the method of Vaynagiy (1973, 1974). To assess the effectiveness of tying, the coefficient of semenification was used. The productivity coefficient was determined.[7,8]

RESULTS

There is a close dependence of plant productivity on the degree of correspondence between growth factors and development to the optimal value that depends on this phenological phase. In the studied samples of broad beans during the research period, the vegetative period lasted for an average of 80 days (77-96 days). The period before seedlings of specimens in individual years lasted 13-20 days. From shoots to the appearance of buds, 21-43 days passed, flowers - 27-41, fruits - 34-57 days. The budding period lasted an average of 15-20 days and began 39-48 days after seed sowing. The early budding of buds was noted in the varieties: White large-bodied, Bobchinsky, Windsor, Triple white, Bel-1, Bel-2, BH-34.

Analyzing the correlations, we concluded that the increase in the period of "shoots - the beginning of budding" strongly delayed the periods of "shoots - the beginning of flowering" (correlation, r = +0.9) and "shoots - pods formation" (r = +0.9). The total number of vegetation days was the least dependent on the periods from stem to budding and flowering but was closely related to the interstage period "flowering beginning - full maturation" (r = +0.9). Thus, when selecting for early ripeness, the main attention should be paid to the duration of the period after flowering. It should be noted that with the duration of the growing season of broad beans, a positive relationship with the duration of the period before emergence was revealed, and in the case of forage beans this correlation is negative.[9]

Individual seed productivity and its elements were analyzed. The largest number of productive nodes on the main stem was observed in the hybrid sample (16 pieces). In plants with large pods (Belarusian, white large-pod and white pearls), the number of productive nodes was smaller and in the years of research it did not exceed 4 pieces/according to the number of beans from the plant, it should be noted that varieties with long pods (white large-fruited, white pearl, summerman, optics) had fewer pods on the plant (by 6.1-7.7 pieces), and Bobchinsky, the royal harvest, Bel-1, Bel-2 (22.9-26.7 pieces/plant). According to the number of pods in the knot, the best signs were the VN-34, Bel-2, hybrid (1.7 pieces).

The height of attachment of the first pod on the main stem is the decisive sign for the selection of varieties, taking into account the mechanized harvesting. The value of the sign ranged from 13.4 cm (hybrid, 2015) to 31.2 cm (white large-fruited, 2016).

The largest mass of pods in the phase of green ripeness is characteristic for the varieties white large-fruited, white pearl, and summer-dweller (22-25.3 g). The greatest length of beans possessed varieties white pearls, optics, and white large-bodied (16.1-17.1 cm). In all the samples studied, the mass of seeds from the plant averaged 40 g.

Analysis of the correlation between the components of seed productivity of the studied samples showed that the mass of seeds from the plant was significantly correlated with the number of pods per plant (r = +0.8) and the number of pods on the side shoots (r = +0.68). The strongest connection was noted between the weight of seeds from the plant and the number of productive lateral shoots (r = +0.42), the number of productive nodes on the main stem (r = +0.54), the number of inflorescences from the plant (r = +0.36), the number of inflorescences on lateral shoots (r = +0.39). The number of seeds in the bean negatively correlated with the

number of fruits on the plant ($r = -0.46$). It was found that there was a negative relationship between size and number of pods per plant ($r = -0.54$), and not between the size and number of seeds from the plant.

Studies have shown that the samples studied differed in protein content in the seeds, which, on average, by samples, was 25.8% (protein content of the broad beans seeds is 18-33%) [Table 1].

The positive dependence of the protein content in seeds on the mass of seeds from the plant was found ($r = +0.26$). Negative correlation was found for the signs "protein content in seeds" and "number of nodes on the main stem" ($r = -0.41$). The protein content in the seeds was significantly dependent on the weight of 1000 seeds ($r = +0.70$). Our results agree with the data of the authors studying forage beans.[10,11]

Anthocyanins, possessing strong antioxidant, antispasmodic, anti-inflammatory, antiallergic, bactericidal, and antiviral properties, are of great importance in the food and medical industry.[12,13] Despite the fact that beans have long been used for food, there is still little data on anthocyanins in their dark seed peel.

Table 1: The protein content of the broad beans seeds *(Vicia faba* L.)

The name of varieties	Protein content (%)
Gourmet dish	17.5
Hybrid	18.4
Batrom	19.2
VN-34	19.6
Green Jack	21.4
Yankel bialy	22.4
Three times white	23.1
Aquadul	24.0
Leader	24.5
Bobchinsky	24.8
Velena	25.1
Tsar's harvest	25.3
Karmazin	26.5
Children's delight	27.3
Pink flamingos	27.6
Russian blacks	28.6
Windsor	29.4
Belorusskiye	30.3
Bel-1	31.2
White large-fruited	31.2
Optics	31.2
Bel-2	32.4
Dachnik	33.1

Anthocyanins in the seed skin of varieties of vegetable beans Tsarsky vintage, Bobchinsky, and Bel-1 were analyzed. It has been established that the color of the seed coat of the samples from violet to dark violet is due to the biosynthesis of mainly "monomeric" anthocyanins represented by three derivatives of the aglicon of delfinidine: Delfinidine, petunidin, and malvidin. Our results are consistent with the published data on the determination of anthocyanins in other legume plants.[12-14]

The obtained data of the study are in agreement with the conclusions Kurkina *et al.* on fodder beans, on the possibility of combining high productivity and quality of seeds in varieties with a high degree of balance of morphophysiological characteristics of plants, as well as the effectiveness of using their potential in each natural climatic zone of cultivation.[15] In the conditions of the southern training support center Hampton roads (TSCHR), these signs in vegetable beans require further improvement. Consequently, a promising variety of vegetable beans for the southern TSCHR can be characterized by the following ratio of biological and morph-physiological characteristics of plants.

CONCLUSION

1. The study of the initial material of broad beans in the soil and climatic conditions of the Belgorod region made it possible to identify a group of early ripening, with the fastest formation of pods. When selecting for early ripeness of vegetable beans, special attention should be paid to the duration of the periods before emergence and after flowering, which strongly correlate with the duration of the growing season ($r = +0.61$ and $r = +0.87$, respectively);
2. The greatest contribution to the formation of individual productivity of samples of beans was made by such elements as "the number of pods on the plant" ($r = +0.8$) and "the number of pods on the side shoots" ($r = +0.7$);
3. The area of leaflets on a plant of samples of broad beans can serve as an indirect sign of a large mass of 1000 seeds ($r = +0.36$), and also directly indicate the number of flowers ($r = +0.75$) and pods on the plant ($r = +0.95$);
4. Seeds of the studied samples of broad beans contained protein of 18-33%. Indirect index of high protein content in seeds can serve as a sign "number of nodes on the main stem" with an inverse relationship ($r = -0.4$) and "weight of 1000 seeds" with a positive ($r = +0.7$).

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