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'Enrichment, evaluation and maintenance of genetic diversity in garden legume crops'

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Abstract

The economically most important leguminous crops consumed as vegetables are green beans, green peas, and broad beans. One of the most effective tools for improving the quality of leguminous vegetables is the development of new varieties. The aim of this study is to research, maintain, and enrich the genetic resources of garden leguminous crops for diverse source material in the implementation of breeding programs and to familiarize with the breeding achievements of these crops. From 204 accessions, lines, and varieties of garden peas, 52 genotypes of garden beans, and 9 accessions of broad beans, genotypes with optimal functional and nutritional qualities were identified.

Keywords: garden pea, green bean, broad bean, gene pool

Garden leguminous crops are leading in the world and the most widely cultivated in Europe. The economically most important among them as vegetables are green beans, green peas, and broad beans. One of the most effective tools for improving the quality of leguminous vegetables is the development of new varieties. Research on genetic variability in legume germplasm is an important tool for identifying accessions, lines, and/or varieties with optimal functional and nutritional qualities (Santos et al., 2019, Azam et al., 2020).

To this end, we set out to research, maintain, and enrich the genetic resources of garden leguminous crops for creating diverse source material in the implementation of breeding programs.

Material and Methods

During the period 2022–2025, under field conditions in a collection nursery, accessions, lines, and varieties of garden peas (*Pisum sativum* L.), garden beans (*Phaseolus vulgaris* L.), and broad beans (*Vicia faba* L.) were tested, multiplied, and re-multiplied. The field trials included 190 genotypes of garden peas, 52 genotypes of green beans, and 9 genotypes of broad beans. The materials were sown in working plots of varying sizes depending on the seed quantity. Sowing of broad beans and garden peas was done manually in February over the years, and

garden beans in April. Broad beans and garden beans were sown on raised flat beds, in double-row strips with an intra-row spacing of 8–10 cm, while for garden peas, the strip was four-row (80+20+40+20) with an intra-row spacing of 5 cm. The plants were grown according to the technologies adopted for field production of the respective crop. Under greenhouse conditions, due to the small seed quantity, 14 accessions of garden peas were multiplied.

The evaluation of breeding materials was carried out in the "flowering" and "technological maturity" phases.

The main indicators of the trial were:

- Phenological observations to determine the length of the growing period, measured from emergence to botanical maturity in days;

- Morphological characterization, including leaf type, petal coloration, and seed characteristics.

- The harvested seeds were cleaned, measured, and stored.

Results and Discussion

PEA

The tested accessions, lines, and varieties of garden peas under field trial conditions, based on the duration of the growing period, are divided into three groups: early, comprising 20.6% of the studied materials; medium-early, with the largest share of 60.5%; and late, with 18.9%, almost equal to the early group (Fig. 1).

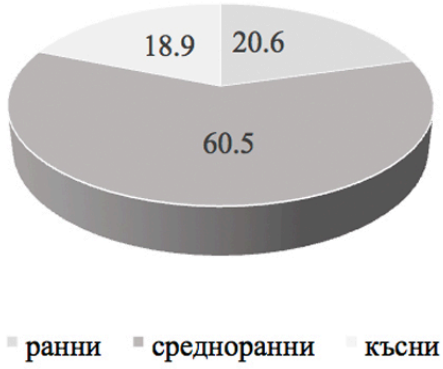


Fig. 1. Distribution of garden pea genotypes according to the duration of the growing period, %



Fig. 2. Leaf type – afila and normal



Fig. 2.1. Color – pink

Of the 204 studied pea genotypes, only three are pink-flowering, all others have white flowers. These three pink-flowering genotypes produce brown-colored seeds. 118 of the materials have a normal leaf type – a compound leaf with 2–3 pairs of small leaflets and tendrils, and 86 have an afila leaf type, where the leaflets of the compound leaf are modified into tendrils (Fig. 2). The plants of the pink-flowering accessions form a red ring at the base of the stipules.

The pods are green, except for one pink-flowering with violet-colored pod edges and brown, large seeds. The fruits are arranged 1, 2, or 3 per peduncle, straight, slightly curved, or sabre-shaped, with varying length and different numbers of seeds within them (Fig. 3).



Fig. 3. Pod tip type – pointed



Fig. 3.1. Pod tip type – blunt

Under greenhouse conditions, pods with neoplasms – an outgrowth of callus tissue from the stomata of ripening pods – were observed in the Sovin variety (Fig. 4). These formations are due to the lack of ultraviolet light in greenhouse conditions (Teshome et al., 2016; Sari et al., 2020).



Fig. 4. Garden pea variety "Sovin" – pod with neoplasm

The color, surface, and shape of the seeds vary from wrinkled to smooth, cream, cream-grayish-green to green, round, spherical, drum-shaped to drum-angular (Fig. 5).



Fig. 5. Color, surface, and shape of seeds in garden pea accessions



Fig. 5.1. Color, surface, and shape of seeds in garden pea accessions

BEAN

During the project period, 11 varieties and 22 breeding lines of garden beans with resistance to *Bean Common Mosaic Virus* (BCMV) and *Bean Common Necrotic Mosaic Virus* (BCMNV) were studied, presented in Table 1. The duration of the growing period from emergence to technological maturity varied across the years from 44 to 57 days. The flowers are white, cream, pale pink, pink, or violet.

Таблица 1. Сортимент и размножения на градински фасул (*Phaseolus vulgaris* L.)

№	Сорт, линия №	Вег. п-д, дни	Цвят на венче-лист	Тип на семената	Кол. семе, kg
1	Капитано	57	бял	бели	1.345
2	Лоди	56	бял	бели, елипсовидни	1.496
3	Тангра	55	лилав	овални, бежови с лилави петна	0.905
4	Еврос	55	бял	бели зърна	1.019
5	Старозагорски чер	55	лилав	черни с бяло пъпче, елиптични	0.512
6	Лястовичи	55	бял	бели с черно петно	0.545
7	Фиеста	55	кремав	бел	0.758
8	Пагане	56	бял	бели	0.468
9	Перун	55	бял	бели	0.760
10	Никос	44	бледороз	кафяви	0.358
11	Мастилен	49	лилав	Бежави с тъмни петна	0142
12	Линия 1105/28/1	59	лилав	кафяви	2.465
13	Линия 1105/19/3	56	лилав	кафяви	0.830
14	Линия 1105/19/4	55	лилав	кафяви и бежави	1.000
15	Линия 1111/41/1	55	лилав	черни	0.675
16	Линия 1111/34/2ч/ч	56	лилав	черни зърна, ср. едри до едри	1.295
17	Линия 1111/34/26/6	56	бял	бели, едри, елипсовидни	0.655
18	Линия 165	57	бял	бели, дребни зърна	1.150
19	Линия 170	57	бял	бели, елипсовидни	0.180
20	Линия 172	52	беж.-бял	бели	0.160
21	Линия 206	56	бял	бели, едри, с жълт ореол	0.320
22	Линия 208	56	бял	бели, дребни, елипсовидни	0.525
23	Линия 213	46	Беж.-бял	бели	1.457
2	Линия 242	56	бял	бели, дребни	1.400
21	Линия 264	56	бял	бели, дребни	1.080
22	Линия Мутантна	50	лилав	черни	0.621
23	Линия 1105/19/5-1	55	бледороз	кафяви	0.472
24	Линия 1105/19/5-2	55	бледороз	кафяви	0.691
25	Линия 1105/19/6-1	55	бледороз	кафяви и кафяви с шарка	0.527
26	Линия 1105/19/6-2	53	бледороз	кафяви	0.165
27	Линия 1105/24/7-1	50	бледороз	кафяви и бели	0.271
28	Линия 1105/24/7-2	51	бледороз	кафяв, каф. с шарка и бели	0.142
29	Линия 1105/24/7-3	53	бледороз	кафяв, каф. с шарка и бели	0.382
30	Линия 1105/24/10-1к	53	бледороз	бели и кафяви	0.110
31	Линия 1105/24/10-2к	50	бледороз	кафяви и бели	0.067
32	Линия 1105/24/10-2б	48	бледороз	бели	0.025
33	Линия 218	53	бял	бели	0.035

The pods are yellow or green, flat or flat-round, green with spots in Mastilen. The color and shape of the seeds vary from white, cream, brown, and black with speckling in Lyastovichi, Tangra, and Mastilen (Fig. 6). Segregation for the seed color trait occurs in lines: 1105/19/4, 1105/19/6-1, 1105/24/7-3, 1105/24/10-1k (Table 1).



Fig. 6. Seed color in lines: 208, 1105/19/4 – segregation



Fig. 6.1. Variety Mastilen

BROAD BEAN

Two accessions of broad beans of local origin and five provided by IFK-Pleven were harvested. The duration of the growing period, flower and seed color, and the quantity of seeds obtained are reflected in Table 2.

Таблица 2. Сортимент и размножения на бакла (*Vicia faba* L.).

№	Образец №	Вег.п-д, дни	Цвят на венчелист	Тип на семената	Кол.семе, kg
1	Бакла Fb2	98	бял	Едри плоско-продълговати, бежови от светли към тъмни	0.145
2	Бакла Fb6	96	бял	Дребни, леко закръглени бежово-кафяви	0.160
3	Бакла Fb7	99	бял	Едри, продълговато-плоски, светло бежови	0.190
4	Бакла Fb8	96	бял	Едри, плоски, продълговати, бежови до светло кафяви	0.195
5	Бакла Fb9	97	бял	Едри, плоски, продълговати, тъмно лилави	0.140
6	Бакла Ангелова	101	бял	Сплеснпрод.-овални, кем.-беж. до шоколад, гладки	0.195
7	Бакла Динк	99	бял	Едри, продълговати, плоски бежови	0.335

The plants have an erect stem, reaching a height of up to 120 cm (Fig. 7). The flowers are white, with a characteristic dark spot on the wings. The fruit is a pod, which at technological maturity is tender and delicate. After that, it quickly becomes coarse and loses its consumptive qualities. The seeds are the largest compared to other vegetable crops. Linear dimensions, absolute weight, shape, and color vary among different genotypes.



Fig. 7. Broad bean Angelova and Dink

Conclusion

During the study period, 204 accessions, lines, and varieties of garden peas (*Pisum sativum* L.), 52 genotypes of garden beans (*Phaseolus vulgaris* L.), and 9 accessions of broad beans (*Vicia faba* L.) were tested, multiplied, and re-multiplied, from which exceptional accessions, lines, and/or varieties with optimal functional and nutritional qualities were identified.

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