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University legumes collection: morphogenetic analysis

This study has been conducted to highlight the outputs of 2011-12 crop rotation under mountain and steppe (plain) zones in Almaty Region. Principal morphogenetic properties have been studied across the collection of common bean, *Phaseolus vulgaris* L. (Kazakhstani, American, Chinese, Czech, Polish, Russian, and Turkish collections) from different soil and climate areas under mountain and steppe zone conditions of Almaty Region. A number of useful genetic stocks for major economically valuable traits has been identified.

Basic catalogue of stock common bean resources including nearly 40 parental common bean and related cultivars of diverse geographic origin has been compiled to be completed this year by 6 French cultivars of bush and liana common beans (Argus, Coco nain blanc precoce, Triomphe de Farcy, Merveille de Venise, Mistica, and Phenomene manufactured by Truffaut and Vilmorin Ltd.). Investigation on growing domestic collection of cultivars and lines is also in progress.

Keywords: common bean, catalogue of stock resources, growing, morphological features, bioorganic fertilizer.

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Морфогенетический анализ университетской коллекции фасоли

В статье освещены результаты вегетационного сезона 2011-12 года в предгорной и степной зоне Алматинской области. Были проведен морфогенетический анализ фасоли обыкновенной *Phaseolus vulgaris* L. (казахстанской, американской, китайской, чешской, польской, русской и турецкой коллекций) из разных почвенно-климатических зон, находящихся в предгорной и степной зоне Алматинской области.

Составлен основной каталог ресурсов фасоли, который включал около 40 родительских форм и сортообразцов различного географического происхождения. В этом году данный каталог пополнен 6 образцами французской коллекции кустовой и вьющейся фасоли (Argus, Coco nain blanc precoce, Triomphe de Farcy, Merveille de Venise, Mistica, and Phenomene manufactured by Truffaut and Vilmorin Ltd.). Продолжаются исследования по размножению коллекции отечественных образцов и линий фасоли.

Ключевые слова: фасоль, сорт, каталог генетических ресурсов, морфологические параметры, биоорганическое удобрение.

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Мақалада Алматы облысының таулы және далалы аймақтарындағы 2011-2012 жылдардағы вегетациялық кезеңнің нәтижелері көрсетілген. Алматы облысы таулы және далалы аймақтарындағы әртүрлі топырақтық-климаттық аймақтарында үрмебұршақтың қарапайым *Phaseolus vulgaris* L. түрлеріне (қазақстандық, американдық, қытайлық, чехтық, польшалық, орыс және түрік қорлары) морфогенетикалық талдау жүргізілді.

Үрмебұршақтың ресурстарының негізгі каталогы құрастырылды, оған әртүрлі географиялық шығу тегіне байланысты сортүлгілер және 40-тай ата-аналық формалар енгізілді. Биылғы жылы бұл каталог француз қорының бұталы және шырмауықты үрмебұршақтың 6 сортүлгісімен (*Argus*, *Coco nain blanc precoce*, *Triomphe de Farcy*, *Merveille de Venise*, *Mistica*, and *Phenomene manufactured by Truffaut and Vilmorin Ltd.*) толықтырылды. Үрмебұршақ линиясының отандық сортүлгілері қорының көбею бойынша зерттеулер жалғастырылып жатыр.

Түйін сөздер: үрмебұршақ, сорт, генетикалық ресурстар каталогы, көбейту, морфологиялық параметрлері, биоорганикалық тыңайтқыш.

Biological features of common bean. The process of cultivar – as population or hybrid generation for common bean, *Phaseolus vulgaris* L. may be predicted from natural hybridization and natural selection of those forms which are adapted to changing climate conditions within the borders of their areals, and as a consequence, crop's spreading out of those areals to strange territories. Transformation of wild species became especially extensive with human participation, when most appropriate forms from points of feeding, life and cropping conditions had been set out to be sought for [1].

In the course of evolution bushy, large-leafy, early-ripening forms with determinant type of growth, large and average flowers, with non-dehiscent and lacking pergamenter layer pods [2].

Comparing to other legumes, common bean occurred to be more capricious to the soil preferring fertilized sand soils or light clay-containing soils. Cold clay soils moisture by the underground waters are considered to be inappropriate for common bean. Soil swamping caused by high acidification may decrease crop harvests, too [3]. Due to acidic soils the development of nitrogen-fixing (tuber) bacteria is detained, and the effect of the nitragine is weakened [4]. Neutralization or lime formation (calcification) of acidic soils lead to increasing yields of common bean.

Under mountain and steppe (plain) conditions of Almaty Region morphogenetic traits for 37 collection cultivars of common bean from different soil and climate zones (Kazakhstan, Chinese, Polish, Russian, Turk, and Czech collections) have been assessed.

Materials and methods

This study has been fulfilled under 2011-2012 field crop rotation in mountain and steppe (plain) zones of Almaty Region. 37 specimens of common bean and its relations have been sown for: i, generation and study on domestic cultivars of common bean; ii, setting up the collection to be processed together with the students; iii, development of field and seed research at new “Zhanga Talap” Agrobiocenter of al-Farabi Kazakh National University. Research material has been partly registered as the State Certificate on the subject of author rights No. 612 of 14 May, 2012 titled: “Distribution and exchange of the specimens of grain legume crops”.

Investigation on the collection items has been performed according to a Vavilov Institute and Awassa Agricultural Research Center prescriptions [5-6]. Samples have been sown on plots of 2 x 10 square meters. Double-row sowing with wide inter-row spacing (40-60 cm) has been applied. Seeds have been collected without mechanic engines. Form “Aktatti” has been used as a standard distributed in Almaty Region. Seed collection has been sown not less than in two replicas. Observations, measurements and assays have been conducted in accordance with “Methodical Instructions on The Study of The Collection for Grain Legume Crops” issued by a Vavilov Institute and relying on the Classifier’s gradations for the genus *Phaseolus* L. [7]. To provide computer planning of the specimens to be planted, the own software programme entitled “Planting manager” (the State Certificate on the Subject of Authorship Rights № 1034 of 1 August, 2012) has been implied.

Structural analysis of common bean plants has been carried out by a range of main traits such as: stem height in cm; length and width of upper leaf at 30-th, 45-th and 65-th days of vegetation, cm; number of pods and number of seeds per plant in pieces; number of seeds per pod; weight of seeds per plant (seed productivity) in g; 100-seed weight, g, and others. Average leaf elongation or width extension has been calculated in percentage (%) as average value between the upper leaf length at 30-th day and 45-th day of vegetation compared with the same parameter for the 65-th day of vegetation.

Statistic treatment of the data obtained has been performed by the technique of variation statistics [8].

Results and Discussion

Seed stocks for the mountain zone have been sown at two sites, and namely: i, the territory of the Institute of Botany and Phytointroduction of the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan; ii, mountain plot in the Almarasan Gorge along the River Bolshaya Almatinka (800-1200 m above the sea level). Seed stocks for the plain zone have been sown at the territory of “Zhanga Talap” Agrobiocentre of al-Farabi Kazakh National University and Kazakh Institute of Soil Science and Crop Research (both nearly 600 m above the sea level).

17 cultivars and lines of common bean, *Phaseolus vulgaris* L. have been planted in the mountain zone (9 – at the territory of the Institute of Botany and Phytointroduction; 8 - mountain plot in the Almarasan Gorge). 20 cultivars and lines of common bean and its relations (broad bean, *Vicia faba* L. and Turkish beans, *Phaseolus coccineus* L.) have been planted in the steppe zone (“Zhanga Talap” Agrobiocenter). With reference of the Czech collection of introduceable cultivars, it has been established that at the 30-th day after the sowing cv. “Zuzka” has displayed the highest germination rate (53,0%). Two other Czech cultivars have revealed germination degrees of 23,3% (cv. “Katka”) and 16,6% (cv. “Luna”). Cv. “Zuzka” has also been determined to surpass other cultivars by leaf size (11,2 x 8,0 cm), whereas these parameters for cvs. “Katka” and “Luna” have made up 6,5 x 4,5 and 9,3 x 6,4 cm, respectively. At the same time it has been noticed too that cv. “Zuzka” would be characterized by earlier transition to the stage of flower formation.

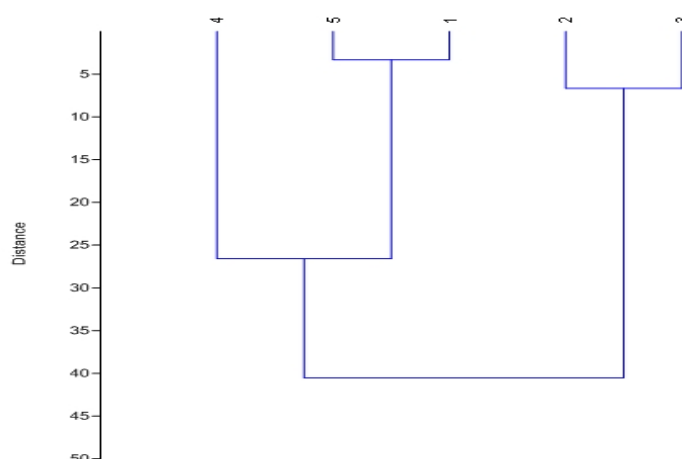
Morphogenetic studies of stock genetic resources for breeding and phenological observations over the process seed germination. Using patterns of Czech and domestic cultivars and lines, it has been indicated that local lines would take over Czech samples to be introduced by the rate of germination (see Table 1).

Germination values for cv. “Zuzka” have reliably exceeded similar data for other Czech cultivars under the study.

It has been shown that common bean leaves under local conditions have possessed egg-like or transitional to wide egg-like form. Some cultivars and lines have been recorded to have silver-polished stipules and differences in leaf colour which is known to be a characteristic genetic trait intrinsic for the cultivar. This trait is dependent on plant age, the extent of soil fertility and fertilizer concentrations which were induced. As shown in Figure 1, by germination rates processed by computational cluster analysis, local line “Nazym” is closer to cv. “Zuzka” and other local line “Talgat” but is distantiated from other cultivars and lines. Thus the line “Nazym” seems to be unique by this morphogenetic feature.

Table 1 – Results of phenological observations: intermediate evaluation of germination rates for Kazakhstan and Czech specimens of common bean (30-th day after sowing)

| № | Cultivar or line | Germination, % |
|-----------------------|------------------|----------------|
| 1 | Zuzka | 53,33± 0,15*** |
| 2 | Katka | 23,33± 0,10*** |
| 3 | Luna | 16,67± 0,10 |
| 4 | Nazym | 78,26± 0,25*** |
| 5 | Talgat | 50,00± 0,20*** |
| Footnote: *** P<0,001 | | |



1 – Zuzka; 2 – Katka; 3 – Luna; 4 – Nazym; 5 – Talgat

Figure 1- Cluster analysis by evaluation of germination rates for Kazakhstan and Czech specimens of common bean (30-th day after sowing) (see Table 1)

Propagation of common bean collection in Kazakhstan is in progress. One of the factors for positive dynamics is a great polymorphism of stocks under ongoing study and possibility to introducing foreign samples, and in that particular case Czech collection. In the mountain zone of Almaty Region (mountain plot in the Almarasan Gorge) it has been established that three cultivars, cvs. “Zuzka”, “Katka”, and “Luna” (Figure 2) from four varieties of Czech collection attempted to be introduced in 2012 would indicate traits of high productivity with the exception of cv. “Jitka” which didn’t sprout at all.

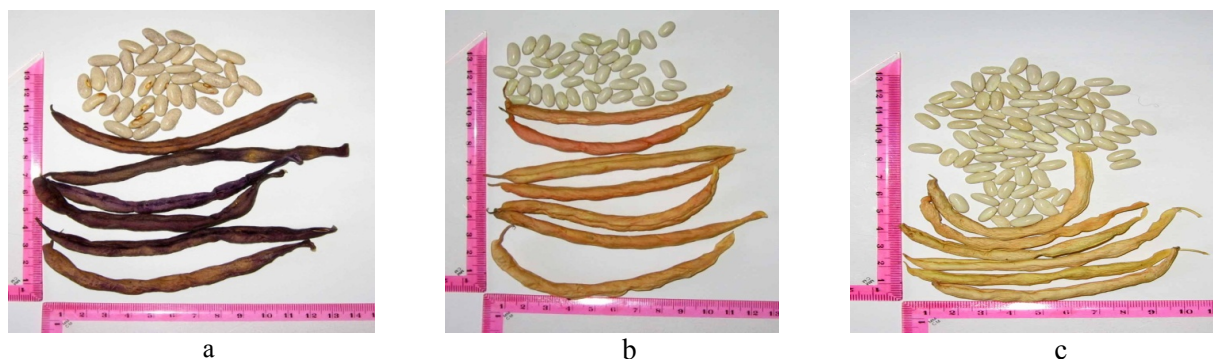
Seed material obtained for cvs. “Zuzka”, “Katka”, and “Luna” would be used for further propagation in the steppe zone, at the territory of “Zhanga Talap” Agrobiocentre. However, all Czech cultivars have shown high susceptibility to bean weevil (*Acanthoscelides obtectus* Sav.) at room temperature. The most early ripening cultivar has been detected to be cv. “Luna” that had a maturation period of 80 days from the very onset of ontogenesis. Other cultivars have ripen to reach the stage of technical ripeness 10-12 days later. As seen from table 2, maximal size of ripen pod on the 92-th day since planting is typical of cv. “Zuzka” (13.3 ± 0.1 cm). The same value for cvs. “Katka” and “Luna” has been determined to make up 12.0 ± 0.2 cm and 10.8 ± 0.1 cm, respectively. Local line “Aktatti” has close pod length in range of 11.0 ± 0.1 cm (the data are

not presented in Table 2), whereas other local lines, “Nazym” and “Talgat” have exhibited in the same period mature pod length reaching 12.4 ± 0.1 and 9.0 ± 0.2 cm, respectively.

Pod length values for cv. “Zuzka” and line “Talgat” have reliably excelled the same parameter of other cultivars and lines under investigation.

In the steppe zone (“Zhanga Talap” Agrobiocenter) patterns of American, Polish and Russian common bean have been successfully propagated. It has been demonstrated that cvs. “Bijchanka”, “Camelia”, “Red Goya” and “Ufimskaya” introduced would be most adapted to the steppe zone.

Using local “Aktatti” line the effect of new domestic bioorganomineral fertilizer has been shown on morphogenetic traits of common bean plants.



a – cv. “Zuzka”; b – cv. “Katka”; c – cv. “Luna”
Figure 2 – Czech cultivars at the stage of technical ripeness

Table 2 – Outputs of structural analysis of Kazakhstan and Czech cultivars and lines of common bean

| No | Cultivar or line | Number of seeds per pod (92-th day of vegetation) | Pod length (92-th day of vegetation) |
|----|------------------|---|--------------------------------------|
| 1 | Zuzka | 6 ± 1 | $13,3 \pm 0,1^{***}$ |
| 2 | Katka | $7 \pm 1^*$ | $12,0 \pm 0,2^{***}$ |
| 3 | Luna | $13 \pm 1^{***}$ | $10,8 \pm 0,1^{***}$ |
| 4 | Nazym | 4 ± 1 | $12,4 \pm 0,1^{***}$ |
| 5 | Talgat | 4 ± 1 | $9,0 \pm 0,2$ |

Footnote: * $P < 0,05$; *** $P < 0,001$

Based on the survey over morphogenetic traits of available seed stocks, the catalogue of main parental cultivars for common bean has been designed. It has included nearly 40 parental specimens of common bean and its relations of diverse geographic origin. These cultivars and lines are supposed to be completed this year by 6 French cultivars of bush and liana common beans (“Argus”, “Coco nain blanc precoce”, “Triomphe de Farcy”, “Merveille de Venise”, “Mistica”, and “Phenomene” manufactured by Truffaut and Vilmorin companies). Investigation on growing domestic collection of cultivars and lines is also in progress to be studied by biochemical, cytogenetic and other properties as used for breeding purposes.

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