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University bean collection: its extension and study for morphogenetic traits

Basic morphogenetic features have been studied across the collection of common bean from different soil and climatic areas. The collection was grown under mountain and steppe zone conditions of the Almaty Region. A number of useful genetic stocks have been identified for agronomically desirable traits. The cv. “Luna” from Czech collection is the earliest to reach maturity. Using local “Aktatti” line, the effect of new domestic bioorganomineral fertilizer on morphogenetic traits were investigated, and the fertilizer was shown to increase the yield by as much as 25%. Bean collection has been completed by the addition of six French cultivars.

Keywords: common bean, *Phaseolus vulgaris* L. technical maturity, germination

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Университеттік үрмебұршақ коллекциясын толықтыру және морфогенетикалық ерекшеліктерін зерттеу

Мақалада әр түрлі топырақ-климаттық аудандарда өсірілген үрмебұршақ коллекциясының негізгі морфогенетикалық ерекшеліктерін зерттеудің нәтижелері келтірген. Коллекция Алматы облысында таулы және далалық аймақтарында өсірілген. Чех коллекциясының «Луна» сортүлгісінің ерте жетілу мерзімі анықталды. Морфогенетикалық белгілері бойынша жүргізілген кластерлық талдау казақстан және чех линияларының арасында өну қабілеті бойынша айырмашылықтарды табылды. Жергілікті «Назым» линиясы чех линиясы "Зузка" сортына жақын, ал жергілікті "Талгат" линиясы басқа чех сорт линиялары "Катка" и "Луна" қарағанда алшақ. Жергілікті "Актатти» линиясының бір қатар мофогенетикалық белгілеріне жаңа отандық биорганикалық тыңайтқыштың әсері зерттелініп, түсімнің 25%-ке асқаны көрсетілді. Үрмебұршақ коллекциясына алты француз сорты қосылды.

Түйін сөздер*:* кәдімі үрмебұршақ *Phaseolus vulgaris L.*, дән жетілілуі, өну.

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Обогащение университетская коллекция фасоли и изучение ее морфогенетических особенностей

В статье приводятся результаты изучения основных морфогенетических особенностей коллекции фасоли из разных почвенно-климатических зон. Коллекция выращивалась в горных и степных зонах Алматинской области. Было установлено, что сортообразец "Луна" чешской коллекции является самым раннеспелым. Проведенный кластерный анализ по морфогенетическим признакам позволил установить различия по всхожести между казахстанскими и чешскими линиями фасоли. Местная линия "Назым" ближе к чешкой линии "Зузка", в то время как местная линия "Талгат" является более отдаленной от двух других чешских сортов "Катка" и "Луна". С использованием местной линии "Актатти», было исследовано влияние нового отечественного биорганоминерального удобрения на ряд морфогенетических признаков и показано увеличение урожая на 25%. Коллекция фасоли была обогащена шестью французскими сортами.

Ключевые слова: фасоль обыкновенная, *Phaseolus vulgaris L.*, зрелость семян, прорастание.

The breeding outcome of new cultivars for common bean, *Phaseolus vulgaris* L. may be predicted from natural hybrids that are adapted to varying climate conditions within its growing zone. Consequently, the crop’s ability to grow in other areas can be predicted. Transformation of wild species became especially extensive with human intervention, when forms with desirable nutritional quality and agronomic traits had been sought for [1]. During the course of evolution, bushy, large-leaf, early maturity forms with determinant type of growth, large number of flowers, and non-dehiscent pods have been selected [2].

In comparison to other legumes, common bean is more capricious in that it prefers fertilized sandy soils or light clay-containing soils. Cold clay soils with high moisture content are not considered to be appropriate for common bean. In addition, turf formation and soil compaction, caused by high

acidification, may also decrease crop yield [3]Due to acidic soils, the growth of nitrogen-fixing bacteria is reduced resulting in suppression of nitrogen fixation [4]. Neutralization or lime addition (calcification) to acidic soils leads to increasing yields of common bean. Under mountain and steppe (plain) conditions of the Almaty Region, morphogenetic traits of 37 cultivars of common bean from different soil and climatic zones (Kazakhstan, American, Chinese, Polish, Russian, Turkish, and Czech collections) have been evaluated.

This study was carried out under crop rotation in mountain and steppe (plain) zones of the Almaty Region in 2011-2012. Thirty-seven cultivars of common bean and its relatives were planted: i, generation and study on domestic cultivars of common bean; ii, setting up the collection so as to be processed by the students under the supervision of researchers; iii, development of field and seed research capability at new "Zhanga Talap" Agrobiocenter of al-Farabi Kazakh National University.

Materials and methods

Part of stock varieties after preliminary propagation and introduction has been registered as the State Certificate on the subject of author rights No. 612 of 14 May, 2012 entitled: "Distribution and exchange of bean specimens".

Investigation on the varieties of this collection has been performed according to the Vavilov Institute and Awassa Agricultural Research Center protocols [5,6]. Seeds were sown on plots of 2 x 10 meters, using double-row sowing with wide inter-row spacing (40-60 cm) and at least two replicates. The cultivar "Aktatti" was used as a standard for the Almaty Region. To provide computer aid to planning of the work and planting of cultivars our own software entitled "Planting manager" (the State Certificate on the Subject of Property Rights No. 1034 of August, 1, 2012) was used.

Seventeen cultivars and lines of common bean, *Phaseolus vulgaris* L. were planted in the mountain zone (9 - at the field of the Institute of Botany and Phytointroduction; 8 - mountain plot in the Almarasan Gorge). Twenty cultivars and lines of common bean and its relatives (broad bean, *Vicia faba* L. and Turkish beans, *Phaseolus coccineus* L.) were planted in the steppe zone ("Zhanga Talap" Agrobiocenter).

The current paper is focused specifically on percentage of emergence and pod length. Domestic bioorganomineral fertilizer, provided by the Faculty of Chemistry and Chemical Technologies, KazNU, was introduced into soil after 25-35 days post-planting in amounts of 25-30g per plot with subsequent moderate watering. Statistic treatment of the data obtained was performed by the methods of analysis of variance [7,8].

Results and Discussion

In the case of Czech collection of introduced cultivars, it was observed that the cv. "Zuzka" showed the highest percentage of emergence (53.0%) at the 30-th day after sowing under mountain conditions. Two other Czech cultivars showed the emergence of 23.3% (cv. "Katka") and 16.6% (cv. "Luna") under the same conditions. The Cv. "Zuzka" surpassed other cultivars in leaf size (11. 2 x 8.0 cm), whereas these parameters for cvs. "Katka" and "Luna" were 6.5 x 4.5 and 9.3 x 6.4 cm, respectively. Furthermore, it was also noted that the cv. "Zuzka" was much earlier to flower than other cultivars.

Morphogenetic studies of genetic stocks for breeding and phenological observations over the process of sprout emergence indicated that local lines were superior to introduced Czech cultivars with respect to the percentage of emergence.

The percent emergence value for the cv. "Zuzka" was much greater than those for other Czech cultivars that were included in the study. This data are of theoretical and evolutional significance as pod size, germination, seed size and lower stem length for warm-season legumes are considered as domestication-related traits [9]. It has been shown that common bean leaves possess egg-like or transitional to wide egg-like form under local conditions. In addition, some cultivars and lines had silver-polished stipules and variations in leaf colour, which is known to be a characteristic genetic trait intrinsic for the cultivar. This trait is dependent on the vegetative stage of the plant, soil quality and amounts of fertilizer applied.

One of the tasks of this study was to determine superior lines by examining phenotypic data for percentage of emergence obtained from a mountain location in 2012 in comparison with elite Czech common bean cultivars. This kind of cluster analyses based on other phenotypic characteristics (branch angle, height, hypocotyls diameter, lodging, maturity, upper pods, pods per plant, and yield) was performed by Canadian researchers [10]. Cluster analysis showing the germination rate differences between Kazakhstan and Czech lines of

common bean (30-th day after sowing). The local line "Nazym" is closer to the cv. "Zuzka", as is another local line "Talgat", which is more distant from two other Czech cultivars, "Katka" and "Luna". This suggests that the line "Nazym" is unique by this morphogenetic character. This graph includes local and Czech lines only as Czech cultivars were introduced into the mountain zone in 2012. Noteworthy, similar approach was used for demonstrating genetic resemblance of the European and the North African faba bean germplasms which were closely associated with their geographical origins and ecological habits [11].

Propagation of common bean collection in Kazakhstan is in progress. Similar research towards the enrichment and analysis of national bean collections is being done by other researchers [11, 12].The objective of the Chinese investigation [13] was to evaluate a collection of domestic landraces for the genetic variability, genepool identity and relationships within and between the groups identified among the genotypes. The landraces were clustered into two genepools.

Polish researchers evaluated the genetic diversity among commercial varieties and local landraces of the *Phaseolus* dwarf common bean and the *Phaseolus* runner bean to reveal a considerable polymorphism of *P. vulgaris* and *P. coccineus* accessions which formed distinct groups [14]. One of the positive outcomes of present study is the amount of polymorphism in stocks and possibility of introducing foreign cultivars, the Czech collection in particular. In the mountain zone of the Almaty Region (mountain plot is in the Almarasan Gorge) it was established that three cultivars, cvs. "Zuzka", "Katka" and "Luna", among the four of Czech collection, introduced in 2012, have a highly desirable traits such as high yield and early maturity deserving further study. The fourth cultivar cv. "Jitka" didn't sprout at all and will not be included in future studies. Seed material obtained from cvs. "Zuzka", "Katka" and "Luna" will be used for further propagation in the steppe zone, in fields of "Zhanga Talap" Agrobiocentre. However, all Czech cultivars have shown high susceptibility to bean weevil *(Acanthoscelides obtectus Sav.)* at room temperature. Cv. "Luna" was observed to be the earliest to reach maturity with a maturation period of 80 days after planting. Other cultivars reached the same stage of maturity 10-12 days later. The data showed that the maximal size of mature pod was attained on the 92-th day after planting, and it belonged to cv. "Zuzka" (13.3 $\pm$ 0.1 cm). The pod size values for cvs. "Katka" and "Luna" were 12.0 $\pm$ 0.2 cm and 10.8 $\pm$ 0.1 cm, respectively. The local line "Aktatti" had similar pod lengths in the range of 11.0 $\pm$ 0.1 cm, whereas other local lines, "Nazym" and "Talgat" had pod sizes of 12.4 $\pm$ 0.1 and 9.0 $\pm$ 0.2 cm, respectively, at their technical maturity stage.

Pod length values for cv. "Zuzka" and line "Talgat" were clearly much greater than those of other cultivars and lines investigated. . Cluster analysis indicating differences in amounts of essential amino acids between Kazakhstan, Czech and other cultivars and lines of common bean. The local line "Nazym" is unique by this biochemical character too, taking over other cultivars and lines.

In the steppe zone ("Zhanga Talap" Agrobiocenter) American, Polish and Russian common bean lines have been successfully propagated. These observations indicate that cvs. "Bijchanka", "Camelia", "Red Goya" and "Ufimskaya" would be most adapted to the steppe zone if they were introduced into that zone..

Using local "Aktatti" line, we investigated the effect of new domestic bioorganomineral fertilizer on morphogenetic traits of common bean plants. The results show that, the yield of this line can be increased by 19-25%, irrespective of climate conditions.

Based on the survey of morphogenetic traits of available seed stocks, a catalogue of main parental cultivars for common bean has been developed. It includes about 40 parental specimens of common bean and its relatives of diverse geographic origin. Out of the Czech bean collection introduced in the mountain zone, the cultivar to reach maturity earliest was cv. "Luna" (80 days of maturation), whereas other cultivars reached their technical maturity 10-12 days later than "Luna". As for germination percentages, tested by computational cluster analysis, the local line "Nazym" being closer by maturity date to cv. "Zuzka" and other local bean line "Talgat", appears to be more promising to be grown commercially in southeast regions of Kazakhstan on the basis of this and its other desirable traits.

In addition to Czech and local cultivars and lines, six 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), are currently being investigated. Five of these cultivars (except cv. "Coco nain blanc precoce") show high or average productivity (the data are in progress).

Investigations on domestic collection of cultivars and lines are also in progress with respect to biochemical, cytogenetic and other properties for use in further breeding work.

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