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To promoting domestic legume and pumpkin germplasms in Kazakhstan

Abstract

The study is concentrated on Kazakhstan legumes as food and heirloom pumpkins, generation and introduction of their varieties and lines by using already created and developing seed bank which enlists domestic as foreign accessions and cultivars from Russia, EU countries, USA and Asia. Some of common bean cultivars introduced in the mountain zone with strictly continental conditions have demonstrated appropriate seed germination, maturation rates and dehydration tolerance. By seed weight and other seed parameters generated domestic cultivars have been shown to exceed other domestic cultivars, lines as external accessions and cultivars. Comparing to common bean, azuki bean under the mountain-zone cropping has indicated delayed leaf vegetation and belated onset of the flowering and pod formation. This has caused the "wavy", or repeated anthesis in hot and dry conditions. Combined germplasm of food and heirloom pumpkins includes 34 different varieties. Wheat sector intrinsic for Kazakhstan should be obviously extended by the introduction of other cereal and vegetable crops based on research incentives and recommendations.

Keywords: germplasm, common bean, pumpkin, productivity, variety (cultivar, or cv), seed parameters.

Introduction

Legumes and pumpkins, when harvested under harsh continental conditions of Kazakhstan, may exhibit essentially high variation of plant and seed parameters, growing periods and harvest structure. Such a great variability completed by increased cross-pollinating ability under conditions of drought, high temperature and the vicinity of blossoming gardens in the mountain zone of Almaty Region may be used for the development of new varieties, especially taking into account substantial water deficit which Kazakhstan and neighbouring Central Asian states (except Kyrgizstan) are facing at present. So, natural stress imposed by instant temperature fluctuations, extreme sun irradiation, lack of water and drastic diurnal, nocturnal and seasonal changes lead usually to visible phenotypic alterations, if compared with those less traceable in the conditions of moderate climate. Data with this respect have been summerized earlier (1-5).

A number of characteristic common bean (*Phaseolus vulgaris* L.) and azuki bean varieties (*Vigna angularis var. angularis* (Willd.) Ohwi & Ohashi) have been studied under local, continental conditions of the high-mountain zone. Germplasm samples have included domestic, "high-protein seed" varieties, and various accessions granted by the Japanese Genetic Bank, a N.I. Vavilov Research Institute of Plant Industry, Russia, and other seed resources located in People's Republic of China, France, Italy, Poland, UK and USA. Some of trialed bean varieties and related species have revealed conspicuous diversity in seed maturation and germination rates, productivity and drought tolerance. As it has been shown, new Kazakhstan cultivars would outstrip a number of annotated external accessions and varieties by seed protein concentration and other remarkable characters. The aim of current article is examining of domestic and foreign bean and pumpkin varieties for their productivity and adaptation under

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harsh continental conditions of the mountain zone of Almaty Region to use optimal parental combinations for subsequent breeding activities.

Materials and methods

A range of foreign varieties (e.g. cvs "Bijchanka", "Bomba", "Camelia", "Cornell", "Dove", "Igolinska", "Laura", "Malinka", "Nicos", "Pinto", "Otrel", "Red Goya", "Sadovod", "Scarlet Emperor", "Supernano", "Ufimskaya", and "Vegetable Sack'es", have been sown on 3x5 m plots in three replications in the mountain area of Almaty Region. Eight azuki varieties including specifically cvs "Dainagon", "Tochigi N1", "Uzuramame" and "Waseazuki" have been sown in rows of 20-28 seeds separated by 50 cm distance in three replications.

Different varieties of food as heirloom pumpkins (cvs "Coloquinte en Melange", "Huannanguan", "Mantnaya", "Vitaminnaya", "Volzhskaya Seraya", "Zucchetto ornamentale" and etc.) have been sown on organically fertilized soil for seed propagation and resistance tests under the mountain conditions of Amaty region in 2010-2011. Foreign common bean cultivars have been screened by the period of seed ripeness, seed productivity and other characters together with three domestic varieties, cvs "Aktatti", "Dzhungarskaya", and "Nazym" obtained autochthonously. Quantitative traits of three common bean varieties were assessed by measuring the seed length and width along with determination of 100-, 200-, 300-, and 1000-seed weights.

List of cultivars trialed in 2011 indicates dry beans, green (snap) beans and lima beans completed by food and heirloom pumpkin varieties trialed and shown in Table 1.

Table 1 - Common bean and pumpkin varieties examined in 2011.

Number	Cultivar	Origin
Common bean varieties and lines, *Phaseolus vulgaris* L.		
1	Allur	Russia
2	Fatima	Gavrish Co., Russia
3	Nazym	Kazakhstan
4	Nikos	Sortovi semena-Ug Co., Bulgaria
5	Shoiynkara	Kazakhstan
6	Sisalle	Russia
7	Supernano	Russia
8	Talgat	Kazakhstan
9	Turchanka	Russia
1	Sutton	UK
2	Ukrainian	Kazakhstan
Pumpkin varieties and lines, *Cucurbita pepo* L.		
Food varieties		
1	Mantnaya	Kazakhstan
2	Volzhskaya seraya	Tukym Co., Oskemen, Republic of Kazakhstan
3	Vitaminnaya	Invent+ Co., Kostanay, Republic of Kazakhstan
4	Zhemchuzhina	Russia
5	Novinka muskatnaya	Russia
Heiloom varieties		
1	Griffe du Diable	France
2	Huannanguan	China
3	Zhucchetta ornamentale	Italy

Statistical significance for pod formation, seed length, width, and seed weight was estimated by using standard EXCELL programmes and by (6).

Results and discussion

In 2008-2011 totally more than 80 bean varieties originating from different countries (e.g. "Nicos" (Bulgaria), "Igolinska", "Bomba", "Otrel" and "Malinka" (Poland), "Ufimskaya", "Bijchanka", "Cornell", "Laura", "Vegetable Sack'es", "Supernano" and "Sadovod" (Russia), "Dove" and "Scarlet Emperor" (UK), "Pinto", "Red Goya" and "Camelia" (USA) have been introduced to the mountain area of Almaty Region and partly granted to the Institute of Potato and Vegetable Plants Research (JSC KazAgroInnovation). These cultivars have shown a proper seed ripeness despite a severe affect of the late drought. Eight azuki bean varieties completed by few broad bean cultivars (*Vicia faba* L.) as lentil (*Lens culinaris* L.), have been trialed under similar conditions of the mountain zone. Interestingly, comparison of the Russian and the Japanese azuki bean resources has allowed to indicate the best accessions with highest yields under these conditions. Despite relatively moderate germination rates, some of these cultivars have confirmed their high thermostability and drought tolerance.

Comparing to common bean, azuki bean, while being cropped in the mountain zone, has been characterized by delayed leaf vegetation and belated onset of the flowering and pod formation. This has caused the "wavy", or repeated anthesis in hot and dry conditions. Cvs Tochigi N1 and Uzuramame have surpassed a number of other common bean and azuki varieties by greater capacity of root network

(data not shown). The advantage comparing to other common bean and azuki varieties may reach 25-30%. This may show that Japanese azuki bean varieties should be more extensively used for the recovery of arable lands or polluted soils as long-lasting rotation crops siderating in the cereal-bean mixtures owing to their relatively long period of vegetation (May-November). Such implication of azuki planting which serve for replacing buckwheat and common bean would facilitate soil enrichment with potassium and phosphorus. Azuki crop is considered also as the source of prospective supplementary food and fodder ingredients.

Lastly, developing Fabaceous collection may be used for extensive student training. In turn, young explorers assist in estimations of seed qualitative and quantitative traits (see Table 2 and Fig. 1).

Table 2 - Productivity of domestic common bean varieties in 2010.

Character	Bean cultivars			
	Dzhungar-skaya	Aktatti	Nazym (Northern Plot)	Nazym (Southern Plot)
Seed length	2.56±0.07	2.53±0.08	2.68±0.08	2.70±0.08
Seed width	0.77±0.06	0.80±0.06	0.85±0.07	0.86±0.06
100-seed weight	50.03±0.22	55.31±0.77	73.49±1.29***	78.19±1.85***
200-seed weight	100.26±0.68	111.15±1.66	146.10±0.40***	156.27±2.39***
300-seed weight	148.87±1.49	167.02±0.44	219.6±1.70***	225.8±0.96***
1000-seed weight	496.23±4.97	556.73±5.83	732.00±6.00***	752.67±3.00***
*** P>0.999				

As indicated in the table, cv. Nazym is leading in productivity since it has depicted the largest seed weight while harvested on both plots.

As demonstrated by subsequent experiments (data not shown), cv. Nazym collected both from Northern, and Southern plots does surpass by certain seed parameters (namely, seed length, width, and 100-, 200-, or 300-seed weights) other domestic varieties. Moreover, in 2011 this variety harvested from open and drastic Northern plot has manifested the yield which occurred almost 7 times greater (1065 seeds) comparing to that one obtained from the same cv. Nazym harvested on a more mild and shady Southern plot (165 seeds, including those 15 motley). At the same time both populations have indicated no statistically significant differences in the rate of pod formation. For example, the reliability criterion ($\mathbf{t_d}$) occurred 7-13 times lower (0.30) than that one characteristic for reliable differences indicated at different probability levels ($\mathbf{t_d}$ 2.11, $\mathbf{t_d}$ 2.90 and $\mathbf{t_d}$ 3.97 at P 0.95, P 0.99 and P 0.999, respectively). This fact may emphasize that cv. Nazym, revealing no differences in pod formation under different conditions of the small-scale cropping, is completely adapted to increased temperatures, severe dehydration and sharp insolation.

Biodiversity and breeding research on food and heirloom pumpkins, *Cucurbita pepo* L. has been initiated at our department in 2009. This diversity of vegetable plant species may be used for delicious meal courses typical of the Central Asian region as a whole, roasted seeds, natural recovery of patients with stomach and liver problems, glowing jack-o'-lanterns and effective soil amelioration. Present collection includes domestic, Russian, Chinese, French (Fig. 2) and Italian species. Collection of French pumpkins by harvesting in the year 2010 has been shown to differentiate substantially by the seed resistance to fungi (data not shown). Referring to numerous reports on nutritional value of the heirloom pumpkin as potential green-house product, especially in the winter period, we may need to revise our present attitude to this miniature pumpkin in our further theoretical and applied breeding programmes to come true. Combined germplasm of food and heirloom pumpkins formally registered in April, 2012 enlists 34 different varieties to be completed by *Cucurbita maxima* Duchesne and other species.

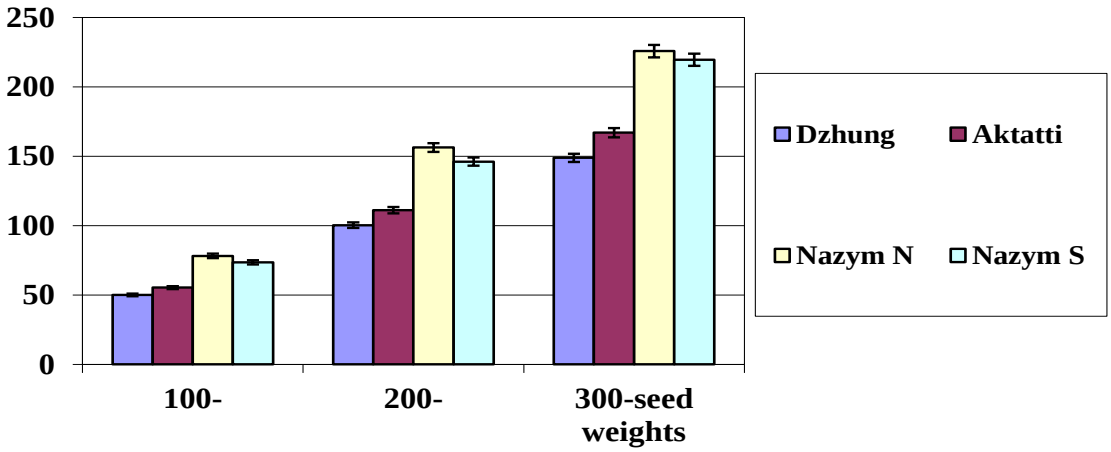

Figure 1 - Comparison of seed weight samples among domestic cultivars (data of 2010; weight in grammes per sample).

South-European as North-Asian areas are referred to as conventional region of vegetables' consumption as related cropping, research and gene engineering manipulations. Realizing the role of Kazakhstan as one of existing as potential vegetable producers open for extensive crop diversification, especially in front of a strengthening global food crisis, Kazakhstan researchers are ready for more fruitful bilateral and multilateral collaborations in all the directions tackled in current paper.

(The set of alternative French heirloom pumpkins, "Coloquinte ern Melange", upon a 2010 harvesting has demonstrated a strong variegation by the seed tolerance to fungi).

Figure 2 - French varieties of heirloom pumpkin ("Griffe du Diable") cropped on enriched soil under mountain zone of Amaty region in 2011.

Conclusions

The series of new common bean varieties have been generated under mountain zone of Almaty Region. Some of them, e.g. cv. Nazym have revealed virtually no differences in pod formation under small-scale cropping at different plots completely fitting to growing temperatures, water deficit as the sun beam. In addition to this, since 2009 the biodiversity and breeding research on food and heirloom pumpkins, *Cucurbita pepo* L. has been undertaken towards enriching domestic, Russian, Chinese, French and Italian germplasms in hand.

Wheat sector intrinsic for Kazakhstan should be obviously enlarged by the introduction of other cereal and vegetable crops based on research incentives and recommendations. To ensure positive impact on food situation in this country and the region as a whole, the Department of Molecular Biology and Genetics of al-Farabi Kazakh National University extensively develops germplasms of common bean, food and heirloom pumpkins. In 2012 the Department staff is creating a brief catalogue of common bean and its relations collection, introducing Czech and Turkish common bean cultivars in the mountain zone, propagate other domestic as brought-in accessions, test new species and technologies of fertilizing the crops under examination (in collaboration with the Department of Physical Chemistry, Catalysis and Oil Chemistry, the Faculty of Chemistry and Chemical Technologies).

These efforts would result in eventual diversification of agriculture in the South of Kazakhstan especially counting a growing pressure of ongoing world food crisis, current trends in the world crop and particularly common bean or pumpkin markets, and obvious need in widening cooperation both with known vegetable research centres and targeted vegetable consumption sites of potential commercial focus for Kazakhstan.

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