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Improved vegetable varieties for Central Asia and the Caucasus developed from AVRDC - The World Vegetable Center Germplasm

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ABSTRACT

After the breakup of the Soviet Union in 1991, all countries in Central Asia and the Caucasus experienced difficulties in obtaining vegetable germplasm for breeding programs. The genebank at AVRDC – The World Vegetable Center conserves a diversity of vegetable germplasm. From 2005-2012, the Center introduced 1370 genebank accessions and 26 improved lines of vegetable species representing 9 families to countries in Central Asia and the Caucasus through the Regional Network for Vegetable System Research and Development. This network fostered faster variety development and dissemination by encouraging partner research institutes to study vegetable crops in regional variety trials under various agroecosystems. Currently a total of 38 new varieties of 12 species are under State Variety Trials. Through collaboration, 35 new varieties of 8 vegetable crops including tomato, sweet and hot pepper, eggplant, vegetable soybean, mungbean, yard-long bean and cabbage have been released and registered in state registries. From 35 new varieties, 14 have been developed by conventional selection methods using germplasm received from the AVRDC genebank. All released varieties demonstrate economically valuable traits: early maturity, high yield, resistance to diseases and pests, high nutrient content and other marketable features. Seeds of released varieties are multiplied by research institutes for distribution to farmers. For the first time, new varieties of non-traditional species such as vegetable soybean, mungbean, yard-long bean and Chinese leafy cabbage have expanded the diversity of vegetables grown in the region, and have become popular for cultivation and consumption. Increasing vegetable production will help diversify diets, increase farmers' income, and enhance the well-being of families throughout the region.

Keywords: Central Asia and the Caucasus, vegetable germplasm, regional variety trials, yield

Introduction

Vegetables are important for food security and livelihoods of people in Central Asia and the Caucasus. Human populations are steadily increasing in the region, and vegetable production is increasing as well: from 13,114,077 t in 2006 to 20,032,668 t in 2012 – an increase of almost 53% in only 6 years. However, this increase came about because the total vegetable sowing area expanded from 682,592 ha to 770,881 ha. Average yield (32.2 t/ha) for vegetables remains below potential yield (FAOSTAT, 2013).

Vegetable diversity in the region comprises about 40 vegetable species including traditional and non-traditional species. The most popular vegetables are cabbages and other brassicas, tomato, watermelon, cucumber, onion, carrot and these occupy most of the crop area in the region. Approximately 15% of the region's total vegetable production occurs during winter from November to March (Ali et al., 2006). This includes production of tomato, cucumber and greens in heated greenhouses and vegetables harvested in autumn to sell in winter and spring.

The region needs more productive varieties with improved resistance to pests and diseases, and tolerance to heat, drought, and saline soils. Underutilized traditional and non-traditional

vegetable crops have yet to be fully exploited (Mavlyanova 2013**b**).

After the breakup of the Soviet Union in 1991, breeding programs in all countries in the region were weakened by the lack of germplasm. AVRDC – The World Vegetable Center's collaboration with the National Agricultural Research and Extension Systems (NARES) of Central Asia and the Caucasus through the Regional Network on Vegetable System Research & Development (CACVEG) became one of the most important sources for vegetable germplasm and a platform for faster variety development and dissemination (Mavlyanova, 2013**a**). This collaboration opened access for researchers who were evaluating vegetable crops in regional varietal trials (Aytbayev et al., 2012; Mavlyanova et al., 2010). New fresh market and processing tomato varieties created business opportunities, and cherry tomato was introduced for the first time (Martirosyan, 2012; Osmanalieva, 2013; Dzhantasov et al., 2013). Evaluation of sweet and hot pepper collections enriched local pepper diversity with new unique varieties (Azimov and Mavlyanova, 2010; Sariksyan and Sagsyan, 2012; Lin et al., 2013). The introduction of non-traditional species encouraged research in new directions, and increased vegetable diversity in the region (Mavlyanova, 2013**c**; Kim, 2013; Kiseleva and Baytureeva, 2013).

Materials and methods

From 2005-2012, the Center introduced 1370 accessions and 26 improved lines of vegetable species representing 9 families (*Alliaceae, Apiaceae, Asteraceae, Brassicaceae, Cucurbitaceae, Fabaceae, Lamiaceae, Poaceae and Solanaceae*) to countries in Central Asia and the Caucasus. This germplasm was evaluated in partner research institutes in regional varietal trials under various agroecosystems in Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. AVRDC's crop production and field guides were used in research institutes. Investigations were carried out in accordance with standard procedures with four replications. Vegetable germplasm was evaluated for biological, morphological and agronomic characters, and commercially valuable traits. Conventional selection methods were used to develop new vegetable varieties.

Results

Through collaboration, 35 new varieties of 8 vegetable crops including tomato, sweet and hot pepper, eggplant, vegetable soybean, mungbean, yard-long bean and cabbage have been released and registered in state registries. Among them, vegetable soybean, yard-long bean and leafy cabbage are non-traditional species introduced to the region for the first time. Genebank accessions as well as breeding lines are good sources for development of new varieties. For example, from 35 new varieties, 14 (40%) were developed by conventional selection methods using germplasm received from the AVRDC genebank. The newly released varieties demonstrate economically valuable traits: early maturity, higher yield than local varieties, disease resistance, high nutrient content and other marketable features. Local names given to new varieties mainly refer to specific characteristics or appearance. Currently, a total of 38 new varieties of 12 species are under state variety trials in eight countries across the region.

***Tomato*:** Some farmers and countries in the region still rely on low-yielding tomato varieties that are 70-90 years old with limited disease resistance. New cherry tomato varieties developed from AVRDC genebank accessions such as Armine (VI006852) and Narek (VI006972) and from improved lines such as Zeytun (CH154), Janna (CLN2413D), Rubina (CLN1558B) in Armenia, and Solnechnaya jemchujina (CLN2070C) and Zolotaya businka (CLN 2071D) in Kazakhstan can open new markets for growers. The new varieties are early, medium and late maturing; indeterminate type; resistant to fusarium, bacterial wilt and tomato mosaic virus; and have plum, roundish, or ellipse-shaped fruit that is yellow, orange or red in color, with fruit weight of 10-25 g and yield potential of 50-70 t/ha.

Fresh market tomato varieties Saadreo (CLN2026D) in Georgia and Alsu (CLN2545A) in Azerbaijan have fruit weight of 95 g and yield potential of up to 70 t/ha. All released varieties have high nutrient content, good transportability and very good processing qualities.

***Hot pepper*:** Although hot pepper is a popular crop in the region, only a few varieties are available. AVRDC germplasm has opened growers' access to new varieties. New early maturing (100 days) variety Punj (VI013538) based on a AVRDC genebank accession was developed in Armenia with small fruits (3 g) but high yield (14.7 t/ha), elongated fruit shape, and red fruit color at the mature stage. New mid-maturity varieties with long conical fruits and red color at ripening such as Zspanak (VI014204) and Kon (VI037591) have been developed in Armenia. Erekshe (VI059345), developed in Kazakhstan, has

large fruits (28-49 g) and yield of 28 t/ha. AVRDC improved lines of mid-maturing hot pepper include Gita (PP0337-7546) with small fruits (5-7 g) and yield of 28 t/ha released in Armenia; Piquant (PP0107-7058) with large fruits (14 g) and yield of 14.5 t/ha released in Kazakhstan; and Uchkun (PP0337-7069) and Tillarang (PP9955-15) released in Uzbekistan, with large fruits (30 g) and yield of 28 t/ha.

***Sweet pepper*:** Sweet pepper germplasm from the AVRDC genebank was used for development of new variety Kaz-Tai (VI046956) in Kazakhstan; it has red fruit color at biological ripening, conical shaped large fruits (125 g) and yield of 22 t/ha. AVRDC improved lines of sweet pepper were used to develop mid- and late-maturing varieties with intense orange color at biological ripening in Armenia: Natali (PP0137-7025) has a cylindrical shape and Emili (PP0137-7041) has a cube shape; both have large fruit size (150-160 g) and yield up to 57 t/ha. Bayan Sulu (PP0037-7645) in Kazakhstan (fruit weight: 125 g; yield: 30 t/ha) and Sabo (PP0437-7031) in Uzbekistan (fruit weight: 80 g; yield: 25 t/ha) are other promising sweet pepper for release. Among red-orange colored fruits, Shodlik (PP0636-6056), developed in Uzbekistan, has a fruit weight of 95 g and yields 26 t/ha. Sweet pepper variety Mili (PBC271) developed in Armenia is late ripening (142 days) with red colored large fruits (160 g) and potential yield of 50 t/ha. The sweet pepper variety Kozy-Korpesh (PP0237-7011) released in Kazakhstan is mid-maturing (120 days) and yields 22.0 t/ha. It has elongated fruits (80 g) with dark green color at technical ripening changing to dark red at biological ripening a quality that has consumer appeal. New sweet pepper lines adapted to hot local climate conditions are being released in Kyrgyzstan, Tajikistan and Turkmenistan.

***Eggplant*:** Genebank germplasm was used to successfully breed Feruz (VI042320), the first new eggplant variety developed in Uzbekistan. Feruz has large, elliptical-shaped fruits (180 g) and yields 32 t/ha.

***Vegetable soybean*:** Soybean is a valuable crop; the green seeds and grain are used to cook a variety of dishes, oil can be extracted from the grain, and the grain and oilcake can be used as livestock and poultry feed. AVRDC introduced vegetable soybean to Central Asia and the Caucasus for the first time, and new varieties have been developed from AVRDC germplasm and breeding lines. Ilhom (VI053823; Misono Green) and Universal (VI032661) have been released in Uzbekistan; Sabostne 1 (VI045038; Jasuto-75) and Mtsvane parkiani (VI044024; AGS292) have been registered in Georgia. Their reduced photoperiod sensitivity and early maturity (95 days) fits in various crop systems, and they are high yielding, producing 9 t/ha of green pods and 3.5 t/ha of seeds, with high protein (42%) and oil (21%) content. New varieties developed from AVRDC improved lines are Inju (AGS-437), a mid-maturity (100 days) variety for Kazakhstan, and Sulton (AGS423), a late maturing (125 days) variety released in Uzbekistan. Sulton has high protein (42.5%) and oil (22%) content. Its green 1000 seed weight is 690 g and its ripe 1000 seed weight reaches up to 250 g; the green pods yield 18-20 t/ha and grain yield is 4-6 t/ha. Research has confirmed the capability of soybean and other vegetable legume crops to increase soil fertility (Mavlyanova, 2013d).

***Mungbean*:** Late maturing varieties grown in Central Asia are subject to lodging and produce crumbled pods. Durdona (VI002984; NM94), an early maturing (70 days) mungbean variety, was developed from AVRDC germplasm. Early maturing AVRDC improved line VC6492-59 has been released as Zhasyl Dan in Kazakhstan and Marjon in Uzbekistan. Mungbean variety Zilola (VC1178) has been released in Uzbekistan. These early maturing varieties are high yielding (2.1-2.8 t/ha) with upright stems; they resist lodging and perform well under heat stress and as a repeat crop. Mid-maturity variety Turon (VC6153B-20G) is characterized by similar traits and has a higher yield (3.2 t/ha) than Zilola, Marjon, and Zhasyl Dan. All these varieties have large marketable seeds, and are appropriate for spring and summer sowing.

***Yard-long bean*:** Oltin soch was developed from an AVRDC genebank accession by multiplying a selection of flowering plants under hot summer conditions. It is a compact bush type. This early maturing variety (80 days) yields green pods (5.3 t/ha) and is well adapted as a repeat crop in Uzbekistan.

***Chinese leafy cabbage*:** New species such as Chinese leafy cabbage (pak choi) have been introduced in Uzbekistan. Early maturing (43 days) variety Sharq guzali was developed by using the polycross method among accessions, with the selection of plants focused on early leaf formation, intensive growth, and tolerance for high planting density. This new variety grows well in greenhouses and tunnels in early spring, as well as in open fields in spring and autumn; it yields up to 20 t/ha.

Conclusion

AVRDC genebank accessions and improved lines have made a significant contribution to the development of new varieties adapted to various agroecosystems in Central Asia and the Caucasus. Seed of released varieties are multiplied by research institutes and distributed to farmers. New varieties of non-traditional species such as vegetable soybean, yard-long bean and Chinese leafy cabbage have expanded the diversity of vegetables grown in the region, and have become popular for cultivation and consumption. Increasing vegetable production will help to diversify diets, increase farmers' income, and enhance the well-being of families throughout the region.

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