

## Report of a Spinacia collecting expedition to the Trans Caucasus

Itinerary, collected material and data

C. Kik, V. Farzaliyev, M. Mosulishvili, G. Melyan & I. Gabrielyan



CGN Report 21

Centre for Genetic Resources, the Netherlands (CGN)



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Centre for Genetic Resources, the Netherlands (CGN), Wageningen Wageningen UR (University & Research centre) November 2011

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#### Foreword

The mission of the Centre for Genetic Resources, the Netherlands (CGN) is to contribute to the conservation, development and sustainable use of plant, animal and forest genetic resources, and hence to global food security, a more sustainable production, rural development, and the conservation of cultural heritage. To that end, CGN currently holds collections of over 20 crops and a total number of accessions of more than 22,500 of interest to the Dutch breeding sector and other users.

To contribute to an effective global system of *ex situ* collections, for each of its collections CGN has analysed the coverage of the crop genepool by the germplasm in its own collection and those of others. In a number of cases, CGN has been able to identify gaps in the total set of collections of a specific crop. Some genetic diversity that is known or can be assumed to exist, appeared poorly represented or even absent from the genebank collections. Such cases warrant new collecting missions, if we wish to conserve as wide a diversity for the crop genepool as possible.

Spinach and especially its two wild relatives form such a case, as only 25 accessions approximately of the two wild relatives are represented in genebanks worldwide. Therefore, in 2008 CGN, in close collaboration with local counterparts, carried out collecting missions in Uzbekistan and Tajikistan focusing on the wild relative *Spinacia turkestanica* and landraces of *S. oleracea*. The present report provides details of the results of a second set of collecting missions carried out in Armenia, Azerbaijan and Georgia by CGN and local experts aiming at collecting landraces of *S. oleracea* but more importantly another wild relative of spinach, *S. tetrandra*. A number of Dutch breeding companies sponsored the mission, a fact that is duly recognized and appreciated.

This second mission has been quite successful. The mission resulted in a harvest of 53 collected samples. Upon regeneration, most of the samples will be made available under the terms and conditions of the Standard Material Transfer Agreement of the International Treaty.

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### 1. Introduction

Collecting landraces of spinach (Spinacia oleracea) and its wild crossable relative S. tetrandra was the aim of this expedition, which made this expedition a single crop expedition. Spinach and its wild relative *S. tetrandra* were chosen because the variation present in the available ex situ collections worldwide of spinach and its two wild relatives was considered too low by CGN and its stakeholders. In this respect the international spinach database (http://documents.plant.wur.nl/cgn/pgr/ LVintro/) shows, that around 2000 Spinacia accessions are available in genebanks worldwide of which ca. 700 accessions of spinach landraces and ca. 25 accessions of the two wild relatives of spinach (S. turkestanica and S. tetrandra). The two wild relatives are especially of importance for breeders as they proved to be a unique gene reservoir in case of the development of cultivars resistant to Peronospora farinosa. Furthermore it could be expected that also genes important for drought tolerance and growth under nutrient poor conditions can be found in these wild species. Given the low numbers of wild relatives of spinach in genebank collections worldwide, CGN carried out in 2008 and expedition to Central Asia to collect S. turkestanica and landraces of spinach. In total 66 accessions of S. turkestanica and two accessions of S. oleracea were collected during this expedition (Kik, 2008). In 2011 a second expedition was carried out to collect accessions of the other wild relative S. tetrandra next to landraces of cultivated spinach. This report is an account of the 2011 spinach expedition.

CGN has the largest spinach collection worldwide with 387 accessions, followed by the USDA (USA) and Vavilov (Russia) collections with 361 and 281 accessions respectively. The spinach collection of CGN one of the most requested collections of CGN with 7747 accession requests since 1988.

The present expedition was carried out in the Trans Caucasus as this area is known to be part of the biodiversity centre of *Spinacia tetrandra* (Uotila 1997). CGN has conducted a large number of expeditions in the past, and the current spinach expedition to the Trans Caucasus fits into this tradition. The present collecting expedition could therefore also benefit from this knowledge and experience when collecting in this part of the world.

In 2011 a Memorandum of Understanding adopting the standard Material Transfer Agreement (sMTA) of the Internal Treaty for Plant Genetic Resources for Food and Agriculture (IT-PGRFA), as a basis for distribution, was signed between CGN and the national authorities on access and benefit sharing in Armenia and Azerbaijan. The national authorities in Georgia agreed to the collecting expedition when the ABS protocol of the CBD would be used as a basis for distribution. Both documents formed the legal basis of the expedition.

## 2. Objectives of the expedition

There were two major aims of this single crop expedition namely:

- to broaden the Spinacia collection of CGN by collection landraces of spinach (*S. oleracea*) and its wild relative *S. tetrandra* for breeding and research purposes, and
- 2. to contribute to the international need for the conservation of PGR.

The choice for a single crop expedition was based on the fact that it proved to be a labour intensive task during the *Spinacia* expedition, which was carried out in 2008 in Central Asia, to locate good collecting sites. In the present collecting expedition this proved to be even more true.

### 3. Members of the collecting team

The various collecting teams consisted of:

Azerbaijan:

• Vahid Farzaliyev PhD, Central Botanical Garden of NAS of Azerbaijan, Baku, Azerbaijan. E-mail: v.farzaliyev@yahoo.co.uk

In West-Azerbaijan assistance was provided by:

• Arzu Guliyev PhD, Azerbaijan State Agrarian University, Dept. of fruit and vegetable growing and viticulture, Ganca, Azerbaijan

In Nakhichevan assistance was provided by:

• Abbas Ismayilli PhD, Institute of Bioresources of the National Academy of Sciences Nakhichevan, Nakhichevan, Azerbaijan.

Georgia:

• Marine Mosulishvili PhD, Ilia State University and Georgian National Museum, 3 Rustaveli Avenue, Tbilisi 0105, Georgia. E-mail: marinamosulish@yahoo.com

In East-Georgia assistance was provided by:

 Merab Khachhidze PhD, Ilia State University, Experimental Station of the Institute of Botany, Shiraki, Georgia.

Armenia:

- Gayane Melyan PhD, Scientific Center of Agrobiotechnology, 1 Isi-Le-Mulino Street 1101, Echmiadzin, Armenia. E-mail: armtoperu@yahoo.com.au
- Ivan Gabrielyan PhD, Department of Higher Plant Taxonomy, Institute of Botany of NAS RA, Str. Acharyan 1, 0063 Yerevan, Armenia. E-mail: ivangabrielyan@yahoo.com

All collecting teams included Chris Kik PhD, Centre for Genetic Resources, the Netherlands (CGN), Droevendaalsesteeg 1, 6708 PB, Wageningen, the Netherlands; E-mail: chris.kik@wur.nl.

In a large number cases also local people (students, farmers) helped us to find material.

## 4. Exploration areas and expedition period

The collecting expedition took place in two major collecting areas which run more or less parallel and which are separated by the lesser Caucasus mountains. In the northern area (in Azerbaijan and Georgia) most *S. tetrandra* populations can be found in the basin formed by the Kur riversystem. In the southern area (in Armenia and Nakhichevan (Azerbaijan)) the populations can be found predominantly in the basin formed by the Aras Nehri riversystem (Figure 1, Appendix 1). The (putative) landraces of *S. oleracea* were collected on bazars and in home gardens.



Figure 1. Map of the collecting area in Azerbaijan, Georgia and Armenia. Red and green circles indicate S. tetrandra and S. oleracea sites respectively (for larger map see Appendix 1).

For the collecting expedition in Azerbaijan, Baku, Gança (West Azerbaijan) and Nakhichevan were chosen as the bases for exploration, whereas in Georgia it was Tiblisi and Dedopolis (East Georgia) and in Armenia Jerevan. For the field work in Azerbaijan a Lada 2017 and a Lada Niva (Nakhichevan) was used, in Georgia a Mercedes ML320 and in Armenia a Mishubitso Pajero. In Azerbaijan and Georgia a driver was included in the expedition, whereas in Armenia one of the collecting team members drove the car. Temperatures during daytime in all three countries varied between 25-40 °C throughout the collecting period.

The determination of the period of sampling of the collecting expedition proved to be a problem as it turned out that the winter of 2010 had been much more severer than the winter in 2009. So when the starting date of the collecting expedition in 2010 in Azerbaijan was determined on May 8, this proved to be too early, as the plants and the seeds attached were still green as we observed in the fields north of Ganca. Based on this observation the collecting expedition was determined three weeks later. This proved a reasonable starting date as most of the plants collected in the first week had brown seeds.

The collecting expedition in Azerbaijan took place from May 28 – June 14 2011 during 15 days, in Georgia from June 15 – 23 during 8 days and in Armenia from June 24 – July 1 during 7 days. For Azerbaijan a collecting period of 15 days was just right, due to the logistics involved. For Georgia the period was also right as much exploration was still needed, but for Armenia a few extra days would have been no luxury as more potential sites could have been visited.

## 5. Data collecting, sampling procedure and period of sampling

A field collecting form based upon a modified multi-crop passport descriptor list (MCPD) was used to document the passport data of the accessions sampled (Appendix 2). All sampled material received a so-called collecting number, in this case FK xx, and MoK xx and MGK xx for the samples collected in Azerbaijan, Georgia and Armenia respectively (FK xx: Farzaliyev - Kik followed by a number, MoK xx: Mosulishvili - Kik followed by a number and MGK xx; Melyan – Gabrielyan and Kik followed by a number). Latitude, longitude and altitude were determined via GPS (Garmin, e Trex series Venture HC) with an inaccuracy of 1-5 meters and pictures were taken of all collecting sites. In addition now and them movies were made.

As a rule of thumb before starting the sampling at a location at least 5 individual plants needed to be seen at first glance. The area explored per accession varied from ca. 0.1-2 ha. The plants of an accession were collected in a plastic shopping bag (50 x 40 cm) and a label with the collecting number was put in the bag. As the plants had spiny seeds along their stems, care had to be taken not to injure oneself. The most practical way to collect plants was to break the stems off at the transition point of the stems with the rooting system. Mostly one plastic bag (containing 25-50 plants) was collected per site. After a number of collecting days partial cleaning took place of the collected material and the seeds (plus a bit of debris) were transferred to a linnen bag (20 x 35 cm) with the collecting label outside and inside of the bag. Upon arrival at

CGN the material was transferred to a conditioned storage room with a temperature of 15  $^\circ C$  and 15% relative humidity.

## 6. Results and discussion

#### 6.1 **Pre-expedition 2010**

When collecting *S. turkestanica* in Central Asia in 2008 no prior detailed information was present to be able to determine (too some extent) the success of a collecting expedition. Although this collecting expedition was a success in terms of the number of accessions collected, the absence of an evaluation moment before the actual collecting expedition to decide whether or not a collecting expedition could be successful, was felt by CGN as a potential risk. Therefore it was decided to carry out a pre-expedition the year before the actual collecting expedition takes place.

Three pre-expeditions concerning spinach LR and *S. tetrandra* location identification were carried out in 2010 by the local experts (see 3. Members of the collecting team; in Azerbaijan dr. Vahid Farzaliyev was assisted during the pre-expedition by dr. Nuyazi Guliyev from the national genebank in Baku).

In Table 1 the results of the pre-expeditions in the Azerbaijan, Georgia and Armenia are given. For Azerbaijan and Armenia there were no doubts about the success of a collecting expedition, but for Georgia there were some doubts as only few accessions were located. An expedition to this country was initiated though, as in the past successful expeditions (paid by the USDA) had been carried out in this country to collect *S. tetrandra*.

Country	Spinacia tetrandra	Spinacia oleracea
Azerbaijan	16	-
Georgia	4	1
Armenia	13	-

Table 1. Results of the pre-expedition carried out in 2010 to identify Spinacialocations.

#### 6.2 Collecting expedition 2011

Spinach (including wild spinach) is locally known as yabani ispanaq in Azerbaijan (or locally in Ganca: somu), in Armenia it is known as spanakh and in Georgia veluri ispanakhi. In total 53 accessions were collected (Table 2) of which 26 accessions from Azerbaijan, 7 accessions from Georgia and 20 accessions from Armenia. In

general the numbers collected were below expectations, as it was thought that around 70 accessions could be collected. This number was based on the expedition carried out in Central Asia when the other wild relative of spinach was collected, namely *S. turkestanica*. Most probably the discrepancy between the expected and actually found accessions was due to the higher human consumption and grazing intensity on *S. tetrandra* compared to *S. turkestanica* (Figure 2 & 3).

Country	Spinacia tetrandra	Spinacia oleracea	Total	
Azerbaijan	21	5	26	_
Georgia	2	5	7	
Armenia	16	4	20	
total	39	14	53	

Table 2. Results of the Spinacia collecting expedition carried out in 2011.

In case of Georgia very few accessions of *S. tetrandra* were found. This was due to the fact that Georgia contrary to the expectations (USDA had carried out in the early 2000s an expedition in the country) has not really a large number of suitable habitats for the growth of *S. tetrandra*. Therefore in this country more emphasis was laid on collecting landraces of *S. oleracea*.

The distance between *S. tetrandra* collecting sites were mostly in the order of several kilometers, although this was not always the case as for MGK 1, 2 & 3; MGK 5 & 6; MGK 11, 12, 13 & 14; FK 5 & 6; and MoK 1&2 the distances between the collecting sites was in the order of hundreds of meters.



Figure 2. Collecting of S. tetrandra by the local people (Azerbaijan) in early spring.



Figure 3. Collected S. tetrandra plants in the spring (Azerbaijan).

#### 6.2.1 *S. tetrandra*: habitats

The habitats where *S. tetrandra* grows are various: along secondary roads, on the borders of rivulets, field margins, in *Hordeum murinum* vegetations, cemetaries, along 'bogara' fields (non-irrigated, not chemically fertilized), and wasteland (nutrient poor tertiary clay soils). Very often one can find the species next to *Artemisia flagrans*, a species which leaves and stems have a silverish gray colour and has a typical smell (Figure 4).



*Figure 4. Collecting accession MGK 16 near Urtsador (Armenia), the vegetation aspect is dominated by Artemisia flagrans, a species with silverish gray coloured leaves and stems.* 

The soil on which *S. tetrandra* grows is mostly a tertiary clay soil, a soil which is more solid then the loess soils on which *S. turkestanica* was found in Central Asia in 2008.

The vegetation in which the species is mostly found has been characterized by Chikov (1983) as 'ephemere Artemisia-etum and salty deserts' (vegetation type 26). This type of vegetation has two subtypes namely 26a: desert and 26b: desert & salty soils (Figure 5). Comparing the vegetation map with the locations where *S. tetrandra* was found one can draw the conclusion that the actual distribution area is only a small part of the potential distribution area.



Figure 5. Vegetation map of part of the Trans-Caucasus (Chikov, 1983). The arrow indicates the vegetation type in which S. tetrandra can be found.

#### 6.2.2 *S. tetranda*: populations

Most of the populations collected were found with help of local people as wild spinach (*S. tetrandra*) is part of their diet and the first vegetable that can be gathered in nature after the winter. For 35 of the 39 accessions enough seeds (more than 4 g per accession; see Appendix 4) from around 50 plants per population were collected. However for the FK 1, 9 & 21 and MoK 2 accessions the number of seeds (actually fruit aggregates) collected was low. This does not mean that these four accessions cannot be regenerated but that more care needs to be taken in the regeneration process of these accessions compared to the other accessions. During first week of collecting in Azerbaijan in the Kur river basin, and when collecting on a greater height in Nakhichevan and Armenia, a few populations had still plants with green seeds. It was decided to collect these plants (and their seeds) as the seeds proved to be firm (FK-1, 12 & 14 and MGK-3). The FK-15 population from Nakhichevan was an interesting

population as it consisted of very young male and female plants(see Figure 6) next to mature female plants. Mature male plants were not found in the populations collected during the expedition as they deteriorate quickly after flowering.



*Figure 6.* Young flowering female (left) and male (right) S. tetrandra plants of accession FK-15 in Nakhichevan and overview of FK-15 site.

The plants collected were mostly small and had an average height of around 20 cm, however also populations with very large plants were found like FK 22, MGK 5, 6, 13 & 14. These populations are all growing in sites where there is no grazing by sheep and goats and also no picking in the spring by local people. Sites which fit this description are for example graveyards but also sites very close to country borders or religious centres. In this context FK 22 and MGK 5 & 6 were collected on cemetaries (Figure 7), MGK 14 was collected near the monastery of Khor Virap (Armenia) and MGK 13 close to the border between Armenia and Turkey.



Figure 7. Large S. tetrandra plants found at the FK 22 (Goyuk, Azerbaijan) location.

Collecting wild spinach proved to be not without risk as already at the first collecting site of the collecting expedition two poisonous snakes were encountered. The only precaution against snake bites was to walk only through low/sparse vegetation and if one had to walk through higher vegetation a stick was used for moving the plants to improve sight on the ground.

#### 6.2.3 *S. oleracea*: landraces

Fourteen putative landraces were collected during the collecting expedition: five in Azerbaijan, five in Georgia and four in Armenia (Table 3; see for landrace locations: Appendix 3). The landraces were collected in bazars and home gardens (Figure 8 & 9).

Country	Bazar	Home garden
Azerbaijan Georgia Armenia	FK 19, 20, 23, 24, 26 MoK 3, 6, 7	MoK 4, 5 MGK 9, 10, 19, 20

Table 3. Landraces collected in the Trans Caucasus in bazars and home gardens.

In Azerbaijan seed production of *S. oleracea* is taking place mainly in the Ganca area. In this area around 15 hectares of spinach seed production is taking place. Other areas that are mentioned by local people where spinach seed production is taking place in Azerbaijan are Samaxi and Sabaribad, however the production areas are rather small (< 1 ha per location). In Georgia ca. 15 hectares of spinach seed production is taking place in the Marneuli – Gardabani area and ca. 5 ha in the neighbourhood of Kutaisi. In Armenia no information was obtained on this subject, which could mean that there is no or insignificant commercial spinach seed production in this country. The seeds of *S. oleracea* that were collected were of the round seed type; no spiny types were found.



*Figure 8. Seed production of spinach (S. oleracea) in home gardens; site: Griboedov, accession nr. MGK-9.* 



*Figure 9. Collecting spinach (S. oleracea) seeds at a bazar; site: Aghda bazar, accession nr. FK 23.* 

Most of the times when a seed seller at a local bazar was visited, it was evident that next to local seeds also seeds from foreign breeding companies were sold; this was especially true for vegetable seeds (Figure 10).



Figure 10. Local and foreign seeds are sold at the bazar; site: Aghda bazar, accession nr. FK 23.

## 7. Conclusions

- a. The Memorandum of Understanding, based upon the sMTA of the IT-PGRFA, was signed between CGN and the national authorities in Azerbaijan and Armenia; with Georgia a CBD arrangement was signed.
- b. The *Spinacia* collection of CGN could be broadened to a large extent as a 39 unique accessions of *S. tetrandra* and 14 accessions of *S. oleracea* could be added to it. This means that the global resources of *S. tetrandra* increased from 10 accessions to 49 accessions, which hopefully will be beneficial for breeding and research activities in spinach.
- c. Although the genetic resources of both global wild relative *Spinacia* collections have been substantially increased in numbers, it is equally true that most probably only a part of the biodiversity of both wild relatives has been collected. For *S. tetrandra* countries like Turkey, Syria, Irak and Iran might still harbour substantial diversity. The same is true for *S. turkestanica* as no or little material from Turkmenistan, Kazakhstan, Iran, Afghanistan, Pakistan, India is available in genebanks worldwide.

## 8. References

- Chikov, P.S. (Editor; 1983). Atlas of areas and resources of herbs of the USSR. All-Union Scientific Research Institute of Medicinal Plants, V.L. Komarov Botanical Institute of Russian Academy of Sciences, Leningrad State University named after A.A. Zhdanov, V. Kuibyshev, Tomsk State University, Department of Geodesy and Cartography at the Council of Ministers of the USSR. pp. 340.
- Kik, C. (2008). Report of a *Spinacia* collecting expedition to Uzbekistan and Tajikistan. Itinerary, collected material and data. CGN report 2008/12, pp. 11 + appendixes (confidential).

## 9. Acknowledgements

This expedition was made possible by the financial support from spinach breeding companies affiliated to PLANTUM-NL and the Dutch Ministry of Economic Affairs, Agriculture and Innovation. Furthermore CK would like to express his sincere gratitude to the other team members who made this trip to a success.

Appendix 1.

Locations of accessions collected in Azerbaijan, Georgia and Armenia





## Appendix 2. Expedition collecting form

#### Azerbaijan-Georgia-Armenia- the Netherlands Spinacia expedition 2011

Team/collector(s)		Collecting nu	ımber	
Date	Pl	noto number		
Crop name	Cu	ltivar name		
Latin species name				
Locality				
Latitude	.Longitude		Altitude	
Samplepopulation	individual	random	non random	
Frequency abundant.	frequent	occasio	nalrare	
Topographyswampflo	od plain…level…u	Indultatingh	illysteepm	ontainous

Biological status of accession (SAMPSTAT)

100) Wild 110) Natural 120) Semi-natural/wild

200) Weedy

300) Traditional cultivar/landrace

500) Advanced/improved cultivar

Collecting/acquisition source (COLLSRC)

10) Wild habitat

- 11) Forest/woodland
- 12) Shrubland
- 13) Grassland
- 14) Desert/tundra
- 15) Aquatic habitat

20) Farm or cultivated habitat
21) Field
22) Orchard
23) Backyard, kitchen or home garden
24) Fallow land
25) Pasture

30) Market or shop

60) Weedy, disturbed or ruderal habitat 61) Roadside 62) Field margin

REMARKS (diseases, pests, other)

## Appendix 3.

Passport data of accessions collected in Azerbaijan, Georgia and Armenia

		ing source population size		nd, grazed small	not grazed medium	en <i>Circium</i> medium		rm, grazed large	not grazed large	not grazed medium	, <i>Hordeum</i> small	wasteland large	vegetation small	vegetation medium	land, ditch small	<i>um</i> , grazed medium	steraceae, large	<i>chorbia</i> sp.	ad in ditch medium	oung + old large	field; local large	use	no grazing medium	not grazed large	ash (seller) -
	remarks	collect		grasslar	along rivulet, grassland, ı	grazed, betwe		in <i>Hordeum murinum</i> , far	roadside, I	roadside, I	wasteland		close to rivulet, high	wasteland, low	waste	in Circiu	high vegetation, A	Eup	along secondary ro	on plain next to A73 road, yo	between rivulet and cereal		next to cereal field,	along rivulet, 1	landrace, Gongorli Ata
lants.		topography		undulating	hilly	undulating		undulating	level	level	undulating	level	level	undulating	level	level	level		level	level	level		level	level	I
e > 50 pr	Altitude (m)			255	218	133		192	188	189	200	194	131	126	75	1029	858		878	606	1120		1021	1129	I
nts and larg	longitude (E)			045,17.515	045,32.425	046,12.666		045,58.952	046,09.513	046,09.292	046,08.385	046,05.418	046,15.818	046,15.220	046,53.191	045,01.803	045,01.810		045,13.812	045,10.556	045,19.174		045,25.446	045,34.674	045,25.544
ı: 15-50 plaı	latitude (N)			41,13.456	41,09.402	40,55.226		40,58.285	40,54.995	40,54.725	40,55.158	40,55.661	41,09.299	41,09.181	40,43.455	39,39.045	39,35.331		39,18.919	39,20.602	39,23.704		39,18.392	39,14.797	39,12.368
1all: 1-15 plants, medium	nearest locality name			Yuxari salahli village	Qirli village, Hasansu river	Samed Vurgun village,	Naziksu river	Bayramli village	Kechili village -1	Kechili village -2	Nyu bulagi	Dallar, C. Cabbarli	Poylu village	Kesemenli	Tanriqulular, Gazandag	Qizilagil	Mahmudkend, Sharur district		Boyukdyuz	Khak	Yenykend		Nazarabad	Nahadji	Djahan bazar, Nakhichevan
1 SIZE - SN	<i>Spinacia</i> species			tetrandra	tetrandra	tetrandra		tetrandra	tetrandra	tetrandra	tetrandra	tetrandra	tetrandra	tetrandra	tetrandra	tetrandra	tetrandra		tetrandra	tetrandra	tetrandra		tetrandra	tetrandra	oleracea
populatio	date			310511	310511	010611		010611	010611	010611	010611	020611	020611	020611	030611	050611	050611		060611	060611	070611		070611	070611	080611
estimated ,	collecting number		Azerbaijan	FK 01	FK 02	FK 03		FK 04	FK 05	FK 06	FK 07	FK 08	FK 09	FK 10	FK 11	FK 12	FK 13		FK 14	FK 15	FK 16		FK 17	FK 18	FK 19

	population size	large	small	large			small	·		medium	small	•	small		ı	ı		large	Medium
remarks	collecting source	landrace, production field, Nasibov (seller)	on secondary road track	not well maintained graveyard	landrace from Ganca; Mehman Chalbiyev (seller)	landrace from Samaxi; Khaliq Mamedov (seller)	bogara field with barley on loess soil	Elmira Saidova (seller)		on cliff	along road	seed shop, Natik Karimov (seller)	home garden, Lia Martiashrili (seller),	seeds from Kara(d)jala, Eibor Durmishran (seller)	seeds from Kutaisi, Shamama Alaverdieva (seller)	Seeds from Gardabani, Vilaiat Navrusov	(seller)	along M2 along the most transmission of the	in small basin, 200 m away from M2
	topography	level	level	level			level	·		hilly	undulating		level		I	ı		undulating	undulating
Altitude (m)		290	117	98	47	752	527	œ		322	320	365	306	501	407	422		1031	1080
longitude (E)		046,23.692	046,18.139	047,15.425	047,28.208	048,38.178	049,01.202	048,28.800		045,02.585	045,02.914	044,57.617	045,59.696	045,32.539	044,48.509	044,48.512		045,10.809	045,10.480
latitude (N)		40,44.311	40,54.164	40,02.422	40,38.533	40,38.542	40,29.530	40,00.434		41,21.296	41,21.082	41,37.272	41,35.839	41,34.737	41,28.846	41,28.282		39,43.969 30 44 373	39,44.414
nearest locality name		Ganca	Gadili	Goyuk	Agha bazar	Samaxi bazar	Shikhzarli	Sabaribad bazar		Khrami gorge, Damgasu - 1	Khrami gorge, Damgasu - 2	Karajala, Gardabani district	Jugaani	lormuganlo, Sagaredjo district	Marneuli bazar - 1	Marneuli bazar - 2		Areni - 1	Areni - 3
<i>Spinacia</i> species		oleracea	tetrandra	tetrandra	oleracea	oleracea	tetrandra	oleracea		tetrandra	tetrandra	oleracea	oleracea	oleracea	oleracea	oleracea		tetrandra	tetrandra
date		080611	090611	100611	110611	110611	110611	120611		150611	150611	160611	200611	200611	210611	210611		240611 240611	240611
collecting number		FK 20	FK 21	FK 22	FK 23	FK 24	FK 25	FK 26	Georgia	MoK 01	MoK 02	MoK 03	MoK 04	MoK 05	MoK 06	MoK 07	Armenia	MGK 01	MGK 03

	population size	large large	large	medium		medium large	large large medium	large small	small
remarks	collecting source	near grapevine not very well maintained pravevard downhill	not very well maintained graveyard,downhill close to entrance of historic settlement	Khurdish settlement home yard; farmer: Simon Jamalyan	home yard; farmer: Khachikh Hovakiuiyan	on stony rocky soil saline semi desert (with <i>Salicornia,</i> <i>Salsola</i> ); close to Turkish border	south facing hill, Turkish border monastery hill along secondary road	south facing slope, loess soil, <i>Artemisia</i> <i>flagrans</i> loess soil, <i>Artemisia flagrans</i>	roadside home garden; farmer: Sonya Muradyan home garden; farmer: Anik Davidyan
	topography	hilly undulating	undulating hillv/steen	hilly level	level	hilly undulating	hilly/steep hilly undulating	hilly undulating/hi	lly undulating level level
Altitude (m)		832 1108	1043	1174 846	851	819 829	837 820 860	1055 1095	1041 867 871
longitude (E)		044,40.959 044,33.320	044,33.653	044,34.423 044,16.523	044,16.202	044,34.264 044,34.030	044,34.160 044,34.638 044,44.480	044,49.150 044,34.126	044,32.929 044,00.420 044,00.463
latitude (N)		39,50.401 40,06.672	40,06.481 40.08.416	40,07.960 40,06.552	40,06.685	39,52.741 39,52.778	39,52.701 39,52.706 39,55.197	39,55.372 40,08.929	40,04.573 40,04.329 40,04.314
nearest locality name		Avshar Nubarashen (former Sovetashen)	Nubarashen (former Sovetashen) Frebuni Jerevan	Jzashen Griboedov -1	Griboedov - 2	Khor Virap - 1 Khor Virap - 2	Khor Virap - 3 Khor Virap - 4 Vedi	Urtsadzor Mushakan	Nubarashen - east Nor Artagers - 1 Nor Artagers - 2
<i>Spinacia</i> species		tetrandra tetrandra	tetrandra tetrandra	tetrandra oleracea	oleracea	tetrandra tetrandra	tetrandra tetrandra tetrandra	tetrandra tetrandra	tetrandra oleracea oleracea
date		240611 250611	250611 250611	250611 260611	260611	270611 270611	270611 270611 270611	270611 280611	280611 290611 290611
collecting number		MGK 04 MGK 05	MGK 06 MGK 07	MGK 08 MGK 09	MGK 10	MGK 11 MGK 12	MGK 13 MGK 14 MGK 15	MGK 16 MGK 17	MGK 18 MGK 19 MGK 20

Appendix 4.

Seed weight of the accessions collected in Azerbaijan (FK xx), Georgia (MoK xx) and Armenia (MGK xx) On the Y- axis the seed weight (g) is indicated and on the X axis the accessions collected in the various countries are given next to the species collected (t: S. tetrandra and o: S. oleracea). On average 18 fruit aggregates ('seeds') per gram.



