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# Resources of *Inula grandis* Schrenk ex Fisch. & C.A. Mey. in South Uzbekistan

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## Abstract

The article describes the resources of underground phytomass *Inula grandis* in the southern part of Uzbekistan. The soil type of the studied areas refers to mountain-crushed (Lithosols) soils. The optimum location for soil types and altitude above sea level is mountainous-crushed soils at altitudes of 1300-1500 m altitudes above sea level. The phytocoenotic optimum is distributed among the herb-shrub-juniper community. The yield of underground phytomass in the Kashkadarya region averages 261.2 kg/ha and in the Surkhandarya region, 236.3 kg/ha. The volume of possible annual harvesting in the Kashkadarya region is 1.24 tons from 7.0 ha of resource areas. These indicators were recorded in the Surkhandarya region: 3.92 tons from 25.0 ha of areas of resource significance.

## Keywords

*Inula grandis*; Southern Uzbekistan; resources; biological and operational reserves; possible annual harvest volume

## Introduction

The genus *Inula* L. includes about 77 species distributed in Europe, Asia and Africa. Species of this genus are mainly perennial, rarely biennial and annual plants (1). Species of the genus *Inula* L. (elecampane) are bushy perennial herbs belonging to the family Asteraceae. There are 9 species found in Uzbekistan: *Inula helenium, I. grandis, I. salicina, I. glauca, I. caspica, I. britannica, I. macrolepis, I. rhizocephala* and *I. multicaulis* (2). However, according to the latest results of scientists, 3 species of *Pentanema salicinum* (L.) D.Gut.Larr., Santos-Vicente, Anderb., E.Rico & M.M.Mart.Ort., *Pentanema caspicum* (F.K.Blum ex Ledeb.) G.V.Boiko, Korniy. & Mosyakin and *Pentanema britannica* (L.) D.Gut.Larr., Santos-Vicente, Anderb., E.Rico & M.M.Mart.Ort. are separated into a separate genus *Pentanema* Cass. (3). The most medicinal species are *Inula helenium, I. grandis, I. rhizocephala* (4). In addition, *Inula helenium* is a wild relative of cultivated plants too (5, 6). According to the results of pasture digression in the steppes of the Inner Tien Shan, *Inula grandis* is an indicator of degradation (7). *Inula grandis* is the main participant in plant communities of honey importance in south Uzbekistan since the projective cover of plants averages 30 % (8).

There has also been research on the species in Central Asia. On the territory of Kazakhstan, *Inula grandis* is widely distributed along the steppe and rocky slopes of low mountains from Tarbagatai to the Western Tien Shan. There are thickets of resource significance in the Zailii and Djhungar

Alatau (9). In Tajikistan, *Inula grandis* grows on latitudinal ridges, without penetrating to the east of the country, where the high mountains of Darvaza and Western Pamir prevent its spread. In the north, the species range is limited by the Kuraminsky ridge and in the south, the Terekli-Tau and Karatau ridges (10). In studies of the ontogenesis of *Inula grandis* in various conditions of Southern Tajikistan, 3 ontobiomorphs were identified: ontobiomorph ontogeny with an orthotropic multi-headed caudex, ontobiomorph ontogeny with a plagiotropic caudex, ontobiomorph ontogeny with a single-headed caudex (11). *Inula grandis* is one of the most common species in the flora of Uzbekistan. This species is widely used in folk medicine to treat various diseases (12). In folk medicine, elecampane is used for tuberculosis, gastrointestinal tract diseases, brucellosis and as an anthelmintic (13). When treating stomach and duodenal ulcers, gastritis, duodenitis, periduodenitis and chronic constipation with a decoction, positive results were obtained in clinical trials and significant improvements were observed in treating stomach cancer (14).

In the composition of tubers and tubers it was determined that there are oils up to 1-3 %, a mixture of 3 seekviterpene lactones from the crystalline part of the oils, namely alantolactan $C_{15}H_{20}O_2$, digidroalantolactan $C_{15}H_{22}O_2$ and alantate acid $C_4H_8N_4O_4$ and 0.16 % alkaloids, acetic and benzoate acids and a small amount of alantol $C_{15}H_{23}O_2$ and proazulene in efir oil. In the roots, up to 44 % are inulin, $(C_6H_{10}O_5)_n$ inulin and in the leaf, the bitter substance is alantopyrine. Apart from these, in the root are vitamins C and E, macroelements K, Ca, Mg and Fe and microelements Mn, Cu, Zn, Mo, Cr, V, Al, Se, Ni, Sr, J and B (15).

Its widespread use is due to the fact that the plant produces biologically active secondary metabolites, among which sesquiterpene lactones, which have a wide spectrum of biological activity, play an important role (16). Phytochemical studies have shown that the roots of *Inula grandis* synthesize 2 sesquiterpene lactones in major quantities: igalane and alantolactone (17).

The underground organs of *Inula grandis* contain essential oil, bitter and mucous substances, saponins, resins, inulin, traces of alkaloids, vitamin E and gums. It is used as of a decoction of the roots as an expectorant for respiratory tract diseases: bronchitis, tracheitis and pulmonary tuberculosis. In addition, elecampane preparations are a good remedy for gastrointestinal diseases (18).

Based on the study of the anatomical structure of the root of *Inula grandis* growing in natural habitats on the territory of Uzbekistan, specific features were identified, such as the fascicular type of root structure, the presence of multirow periderm, the formation of bast fibers in the cells of the bark parenchyma, the presence of large and small schizogenic receptacles and the accumulation of brown contents in them (inulins, resins and essential oils, etc.) (19). According to the anatomical structure of the root of *Inula grandis* growing on the territory of Kazakhstan, signs have been identified, such as the root being polyarchal, the xylem vessels being large and the walls being very thickened. In the secondary cortex and core, there are oval-shaped containers containing biologically active substances (9).

In Uzbekistan, the roots of *Inula grandis* are used as one of the components of raw materials for the production of a substance (anthelmintic drug “Helmintabs”) developed at the Institute of Chemistry of Plant Substances of the Academy Sciences Republic of Uzbekistan (17).

According to the analysis of the last three years (2021-2023) on the need for annual reports of raw materials (roots) of *Inula grandis* in the Republic of Uzbekistan, the average annual volume is 25.0 tons (20).

Based on the above, it is important to identify the areas of resource values of the natural reserves of *Inula grandis* and establish the possibility of collecting raw materials.

**The purpose of the work** is to study the natural resources of *Inula grandis* in different environmental conditions of southern Uzbekistan.

## Materials and Methods

*Inula grandis* is a large perennial herbaceous plant from the family of Asteraceae. Plant 50-120 cm in height (4) (Fig. 1).

Research to determine natural reserves of raw materials was carried out in Kashkadarya (Tarkapchigay, Karadaxana, Akbash: altitude above sea level on average 1300-1500 m) and Surkhandarya (Xazratbobo, Chagam, Duxona: altitude above sea level on average 1300-1500 m) regions of the republic. In each region, 10 monitoring sites were allocated. To determine the natural resources of plants within the Republic of Uzbekistan, the manual “Resource science and standardization of medicinal plant raw materials” (21) was used. Raw material reserves were determined during the plant’s growing season (June-August). The operational reserve of raw materials was calculated as the product of the average yield of key areas by the amount of area occupied by commercial thickets. The volume of possible procurement of raw materials was calculated as the fraction of operational reserves of raw materials per procurement turnover, including the year of procurement and the duration of the period of restoration of the thicket. The yield of air-dried raw materials was calculated to be 30 %. For *Inula grandis*, repeated root harvesting can be carried out in the same place after 4-5 years (21). Analysis of phytocenoses per 100 $m^2$ area with the participation of *Inula grandis* was carried out using the generally accepted methodology (22). In identifying and determining the life forms of plants, the 10-volume monograph “Identifier of Plants of Central Asia” (1968-1993) was used (23, 24). Plant names are presented according to http://www.plantsoftheworldonline.org/, http://www.theplantlist.org/, https://www.ipni.org/ (25-27). To analyze the agrochemical composition and classification of regional soil, the manual “Soil Science and Agriculture” and FAO materials were used (28, 29). To

**Fig. 1.** Habitats of *Inula grandis* Schrenk ex Fisch. & C.A. Mey.

determine the area of thickets, the Farmis application (One Software App) was used based on the allocation of the GPS coordinates of the survey sites. The results obtained were statistically processed in the Past3 and Sigma15 programs.

## Results

### Study area

Southern Uzbekistan includes the Kashkadarya and Surkhandarya regions, which are located in the southernmost part of the republic. The region borders the Samarkand, Bukhara and Navai regions from the north, Tajikistan from the east, Turkmenistan from the west and Afghanistan from the south. The southern border of the region runs along the Amudarya River, which is also the border between Uzbekistan and Afghanistan (Fig. 2).

In recent years, several scientific studies have been carried out in this territory on the cultivation of medicinal plants in rainfed regions based on the study of bio-ecological characteristics (30, 31).

In botanical and geographical terms, the territory of the Kashkadarya region belongs to the Urgut district of the Kukhistan district, the Kashkadarya and Tarkapchigay districts of the West Gissar district of the Central Asian


**Fig. 2.** Study areas.

province and the Karshi-Karnabchul district of the Bukhara district of the Turan province. Surkhandarya region belongs to the Kashkadarya, Tarkapchigai, Baysun, Kugitang and Surkhan-Sherabad districts of the West Gissar district of the Mountainous Central Asian province and the Sangardak-Tupalang district of the Gissar-Darvaz district and the Babatag district of the Pyanj district (32).

### *Soil type of the study areas*

The study areas differ in climatic and soil conditions. It was reported that desert, light gray soils, meadow and swamp-meadow soils are common in the Kashkadarya region (28). In the desert part of the Surkhandarya region, desert gray soils and brown soils are common and in the mountainous part of the region, light brown, meadow-steppe soils are common (24).

To analyze the soil type of the study areas, we used the international soil classification system for soil diagnostics and the creation of soil map legends (29).

According to the analysis of the soil of the Kashkadarya region, 7 types of soils were identified: shifting sands (DS), meadow brown (Ge), mountain-crushed (I), brown (semi-desert (Xk), brown saline and solonchakous (Yk), brown structureless (Yt), meadow solonchaks (Z). In contrast, in the Surkhandarya region, 6 types of soil are noted: meadow-brown (Ge), mountain-crushed (I), alluvial carbonate (Jc), pine forest sands (Qc), brown (semi-desert) (Xk), meadow solonchaks (Z). Based on the results obtained, a map of soil types in Southern Uzbekistan was developed (29) (Fig. 3).

In the Kashkadarya region, I (Lithosols) and Xk (Calcic Xerosols) are the leading soil types and the least common are DS (shifting sands) and Ge (meadow-brown). Unlike the Kashkadarya region, DS (shifting sands) does not apply to the Surkhandarya region. The leading soil types are I (Lithosols) and Ge (Calcaric Gleysol); the least common is Z (Solonchaks).

The soil type of the studied areas belongs to mountainous-gravelly (Lithosols (I) soils. Lithosols belong to the group of Leptosols, which are considered to be on dense rocks and very stony soils (29).

To analyze the composition of the soil (Lithosols) of the study areas, 4 indicators (sand, pH, $N_2$, $CaCO_3$) of the topsoil will be selected. Sand in the top layer of soils in southern Uzbekistan averages 63.4 %, water pH 6.8 %, $N_2$ 0.12 % and $CaCO_3$ 0.125 % (Fig. 4).

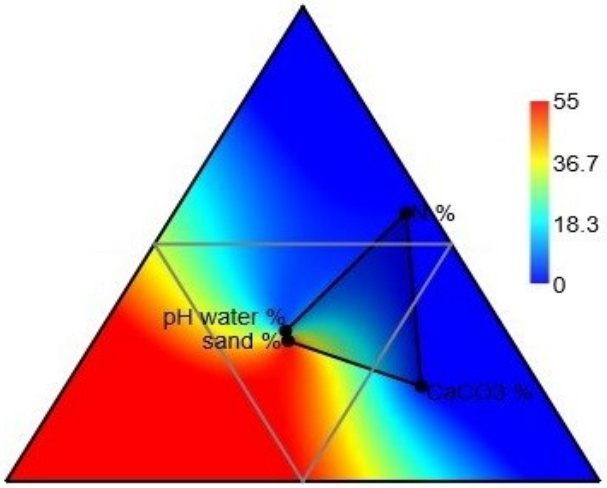
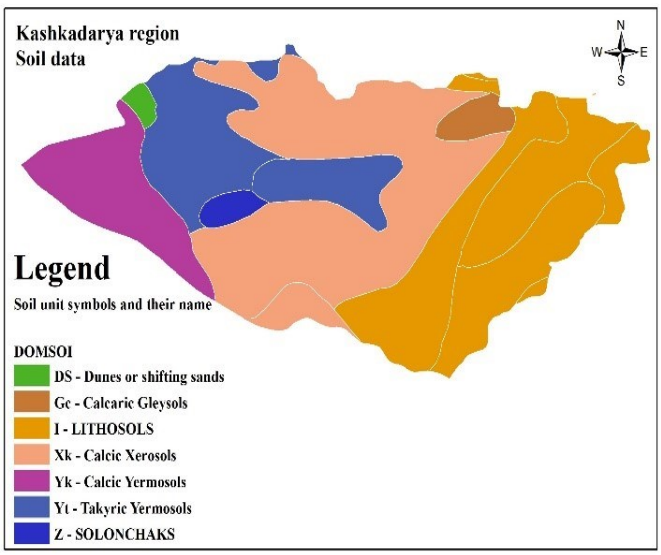



**Fig. 4.** Soil composition (Lithosols) of Southern Uzbekistan.

### *Phytocenotic characteristics of the studied regions*

As a result of field research, we identified 3 cenopopulations (hereinafter - CP) in the Kashkadarya region and 3 CP in the Surkhandarya region with the participation of *Inula grandis*.

59 species of higher plants were identified in the identified coenotic populations in the Kashkadarya region. The first coenopopulation was identified in the botanical-geographical region of Tarkapchigay. This area consists of a forb-tamarica community. In this CP-1, the dominant species is the genus *Tamarix* and 24 species have been identified. Projective coverage 65-75 %. The second CP-2 is allocated to the territory of Karadaxana. This CP-2 is a forb-tamarix community consisting of 30 plant species and the degree of grass cover is 65-70 %. The third CP-3 is isolated from the Akbash territory; it is a forb-shrub-juniper community consisting of 24 species of higher plants. The dominant species is *Juniperus seravschanica* Kom. and *Ephedra intermedia* Schrenk & C.A.Mey. Grass covers 40 % (Table 1).



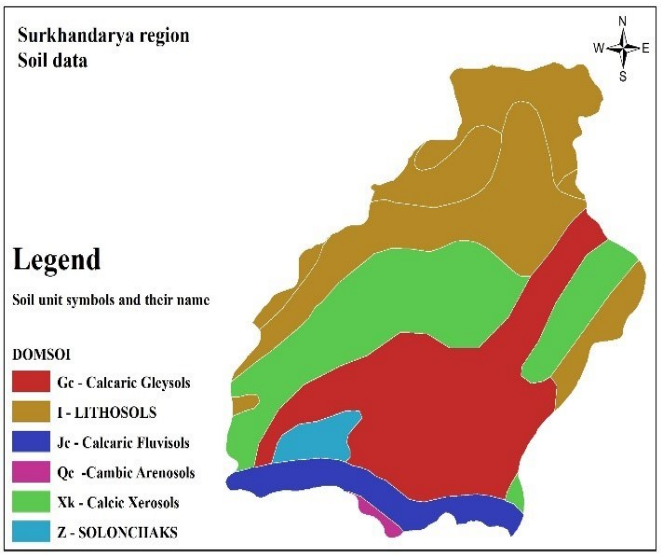




**Fig. 3.** Map of soil types in Southern Uzbekistan.

In the Surkhandarya region, 28 species of higher plants were identified in the selected coenopopulations. CP 1 was isolated from the territory of Xazratbobo and this CP is a forb-bluegrass community. This community consists of 20 species of higher plants and the degree of vegetation coverage is 60-65 %. CP-2 is identified on the territory of Chagam and is a forb-wormwood community. The botanical composition of this territory is not very rich since 15 species of higher plants have been identified. In this CP, the dominant species is *Cullen drupaceum* (Bunge) C.H.Stirt. and projective coverage is 55-60 %. CP-3 was isolated from the territory of Duxona and it is a forb-bluegrass community. Herb cover is about 80-95 % and the community composition consists of 21 species of higher plants (Table 1).

**Table 1.** Species composition of the studied cenopopulations of *Inula grandis* in Southern Uzbekistan.

| No | Botanical name | Life form | Abundance of species, % | | |
|---|---|---|---|---|---|
| | | | SP-1 | SP-2 | SP-3 |
| | **Kashkadarya region** | | | | |
| 1 | *Juniperus seravschanica* Kom. | Trees | - | + | 15 |
| 2 | *Prunus bucharica* (Korsh.) Hand.-Mazz. | Trees | - | 1 | - |
| 3 | *Prunus cerasifera* Ehrh. | Trees | - | - | 2 |
| 4 | *Ephedra intermedia* Schrenk & C.A.Mey. | Shrub | - | - | 8 |
| 5 | *Rosa kokanica* (Regel) Regel ex Juz. | Shrub | - | - | 1 |
| 6 | *Rosa webbiana* Wall. ex Royle | Shrub | - | - | 1 |
| 7 | *Spiraea pilosa* Franch. | Shrub | - | - | + |
| 8 | *Tamarix aralensis* Bunge | Shrub | - | 25 | - |
| 9 | *Tamarix elongata* Ledeb. | Shrub | - | 15 | - |
| 10 | *Tamarix hispida* Willd. | Shrub | 6 | - | - |
| 11 | *Tamarix meyeri* Boiss. | Shrub | 15 | - | - |
| 12 | *Artemisia ferganensis* Krasch. Ex Poljakov | Semi-shrub | - | 3 | - |
| 13 | *Allium giganteum* Regel | Perennial | - | - | 1 |
| 14 | *Allium majus* Vved. | Perennial | - | - | + |
| 15 | *Anemone baissunensis* Juz. ex M.M.Sharipova | Perennial | - | - | + |
| 16 | *Bromus inermis* Leyss. | Perennial | 2 | - | - |
| 17 | *Lactuca orientalis* (Boiss.) Boiss. | Perennial | - | + | - |
| 18 | *Alhagi pseudalhagi* (M.Bieb.) Desv. ex Wangerin | Perennial | - | + | - |
| 19 | *Arctium anomalum* (Franch.) Kuntze | Perennial | - | + | - |
| 20 | *Capparis spinosa* L. | Perennial | 2 | 3 | - |
| 21 | *Cichorium intybus* L. | Perennial | + | + | - |
| 22 | *Convolvulus arvensis* L. | Perennial | - | + | - |
| 23 | *Crambe cordifolia* subsp. *kotschyana* (Boiss.) Jafri | Perennial | 1 | + | - |
| 24 | *Cynodon dactylon* (L.) Pers. | Perennial | 2 | 5 | - |
| 25 | *Delphinium semibarbatum* Bien. ex Boiss. | Perennial | + | 1 | - |
| 26 | *Echinops leucographus* Bunge | Perennial | - | + | |
| 27 | *Elwendia capusii* (Franch.) Pimenov & Kljuykov | Perennial | - | - | + |
| 28 | *Elwendia intermedia* (Korovin) Pimenov & Kljuykov | Perennial | - | - | + |
| 29 | *Eremurus luteus* Baker | Perennial | - | + | |
| 30 | *Eremurus pubescens* Vved. | Perennial | - | - | + |
| 31 | *Ferula tadshikorum* Pimenov | Perennial | 2 | 5 | - |
| 32 | *Ferula kuhistanica* Korovin | Perennial | - | - | 2 |
| 33 | *Ferula moschata* (H.Reinsch) Koso-Pol. | Perennial | - | - | + |
| 34 | *Geranium linearilobum* DC. | Perennial | - | - | + |
| 35 | *Haplophyllum bucharicum* Litv. | Perennial | - | + | - |
| 36 | *Haplophyllum versicolor* Fisch. & C.A.Mey. | Perennial | 1 | | - |
| 37 | *Hordeum bulbosum* L. | Perennial | 2 | + | - |
| 38 | *Hypericum scabrum* L. | Perennial | - | - | + |
| 39 | *Inula grandis* Schrenk ex Fisch. & C.A.Mey. | Perennial | 7 | 5 | 11 |
| 40 | *Iris parvula* T.Hall & Seisums | Perennial | - | - | + |
| 41 | *Mediasia macrophylla* (Regel & Schmalh.) Pimenov | Perennial | - | - | + |
| 42 | *Lepidium ferganense* Korsh. | Perennial | + | + | - |
| 43 | *Poa bulbosa* L. | Perennial | + | + | 2 |
| 44 | *Phlomoides labiosa* (Bunge) Adylov, Kamelin & Makhm. | Perennial | - | + | - |
| 45 | *Rheum maximowiczii* Losinsk. | Perennial | + | 2 | + |
| 46 | *Tragopogon malikus* S.A.Nikitin | Perennial | - | + | - |
| 47 | *Tulipa carinata* Vved. | Perennial | - | - | + |
| 48 | *Sibbaldianthe orientalis* (Juz. ex Soják) Mosyakin & Shiyan | Perennial | - | - | + |
| 49 | *Ziziphora pedicellata* Pazij & Vved. | Perennial | - | - | 2 |
| 50 | *Onopordum acanthium* L. | Biennial | + | + | - |
| 51 | *Aegilops crassa* Boiss. ex Hohen. | Annual | + | | - |
| 52 | *Aegilops triuncialis* L. | Annual | - | 1 | - |
| 53 | *Artemisia annua* L. | Annual | + | + | - |
| 54 | *Avena fatua* L. | Annual | + | + | - |
| 55 | *Ceratocarpus arenarius* L. | Annual | + | + | - |
| 56 | *Lactuca serriola* L. | Annual | + | - | - |
| 57 | *Medicago lanigera* C.Winkl.&B.Fedtsch. | Annual | + | - | - |
| 58 | *Medicago minima* (L.) Bartal. | Annual | - | 1 | - |
| 59 | *Papaver pavoninum* Schrenk | Annual | + | + | - |

| | | | | | |
|---|---|---|---|---|---|
| | **Surkhandarya region** | | | | |
| 1 | *Pistacia vera* L. | Trees | 3 | - | 2 |
| 2 | *Artemisia ferganensis* Krasch. ex Poljakov | Semi-shrub | 10 | 15 | 3 |
| 3 | *Moluccella sogdiana* (Kudr.) Ryding | Semi-shrub | 3 | - | 1 |
| 4 | *Salvia bucharica* Popov | Semi-shrub | 2 | 5 | 1 |
| 5 | *Allium giganteum* Regel | Perennial | 1 | - | + |
| 6 | *Allium jodanthum* Vved. | Perennial | + | - | + |
| 7 | *Capparis spinosa* L. | Perennial | 2 | 1 | + |
| 8 | *Cullen drupaceum* (Bunge) C.H.Stirt. | Perennial | - | 20 | - |
| 9 | *Elwendia capusii* (Franch.) Pimenov & Kljuykov | Perennial | 1 | - | + |
| 10 | *Elwendia hissarica* (Korovin) Pimenov & Kljuykov | Perennial | - | + | - |
| 11 | *Eremurus kaufmannii* Regel | Perennial | + | - | + |
| 12 | *Eremurus olgae* Regel | Perennial | 2 | - | 1 |
| 13 | *Ferula tadshikorum* Pimenov | Perennial | 4 | 2 | 2 |
| 14 | *Haplophyllum bungei* Trautv. | Perennial | + | - | + |
| 15 | *Haplophyllum bucharicum* Litv. | Perennial | - | 2 | - |
| 16 | *Hordeum bulbosum* L. | Perennial | + | - | 40 |
| 17 | *Inula grandis* Schrenk ex Fisch. & C.A.Mey. | Perennial | 4 | 9 | 7 |
| 18 | *Phlomoides lehmanniana* (Bunge) Adylov, Kamelin & Makhm. | Perennial | - | 3 | - |
| 19 | *Rhaponticoides gontscharovii* (Iljin) Negaresh | Perennial | + | - | + |
| 20 | *Cousinia regelii* C.Winkl | Biennial | - | + | - |
| 21 | *Aegilops crassa* Boiss. ex Hohen. | Annual | 5 | - | 5 |
| 22 | *Aegilops triuncialis* L. | Annual | + | 1 | 4 |
| 23 | *Avena barbata* Pott ex Link | Annual | - | + | 5 |
| 24 | *Avena fatua* L. | Annual | 2 | + | 2 |
| 25 | *Diarthron vesiculosum* (Fisch. & C.A. Mey. ex Kar. & Kir.) C.A. Mey. | Annual | - | 4 | - |
| 26 | *Goldbachia laevigata* DC. | Annual | - | + | - |
| 27 | *Hordeum spontaneum* K.Koch | Annual | 25 | - | 5 |
| 28 | *Papaver pavoninum* Schrenk | Annual | + | + | 2 |

## Resources

To determine the underground phytomass of the plant in the Kashkadarya region, 3 monitoring sites of Tarkapchigay, Karadakhana, Akbash of the Dekhkanabad region and 3 sites of Khazratbobo, Chagam, Dukhon of the Uzun region of the Surkhandarya region were selected and 10 recording sites of 10 x 10 m were laid in each site (Fig. 5).

Indicators of registration sites in the size of 10 x10 m in the Kashkadarya region, it is noted that, in the Tarkapchigay area, the presence of individuals is 38.9 ± 2.19 pieces, specimens that have reached productive maturity are 23.8 ± 1.66 pcs. The yield of the survey sites was 1556.8 ± 146.13g wet mass. Accordingly, these indicators were noted at the Karadaxana site: 37.4 ± 2.89 pcs. / 23.5 ± 1.80 pcs. / 1551.6 ± 144.84 g and at the Akbash site 44.9 ± 3.01 pcs /25.2 ± 2.35 pcs / 1243 ± 111.5 g. These indicators were noted to be slightly lower in the Xazratbobo, Chagam and Duxona sections of the Surkhandarya region (Table 2).

**Fig. 5.** Monitoring sites.

**Table 2.** Indicators of monitoring sites *Inula grandis* (10 x 10 m).

| Plots | Availability of plants, pcs. | Specimens of productive maturity, pcs. | Productivity of accounting sites, g(wet mass) |
|---|---|---|---|
| **Kashkadarya region** | | | |
| Tarkapchigay | 38,9 ± 2,19 | 23,8 ± 1,66 | 1556,8 ± 146,13 |
| Karadaxana | 37,4 ± 2,89 | 23,5 ± 1,80 | 1551,6 ± 144,84 |
| Akbash | 44,9 ± 3,01 | 25,2 ± 2,35 | 1243 ± 111,5 |
| **Surkhandarya region** | | | |
| Xazratbobo | 35,1 ± 2,66 | 23,7 ± 2,17 | 1141,2 ± 92 |
| Chagam | 44,7 ± 2,93 | 23,4 ± 1,73 | 1142,6 ± 91,09 |
| Duxona | 43,1 ± 3,04 | 24,9 ± 1,40 | 1456,4 ± 106,2 |

In contrast to the indicators of the regional registration sites, in the Surkhandarya region, much higher hectares of resource value are established. The lowest indicators of areas of resource significance were noted in the Tarkapchigay site (2.0 ha) and the highest in the Xazratbobo and Chagam sites (10.0 ha each). In turn, these indicators affect the possible annual harvest. In the Kashkadarya region, the yield of underground plant phytomass per hectare averaged 261.2 kg and in the Surkhandarya region, 236.3 kg of air-dry mass.

As a result, the volume of possible annual harvesting in the Kashkadarya region was established at 1.24 tons from 7.0 ha of resource areas. These indicators were noted in the Surkhandarya region: 3.92 tons from 25.0 ha of areas of resource significance (Fig. 6).

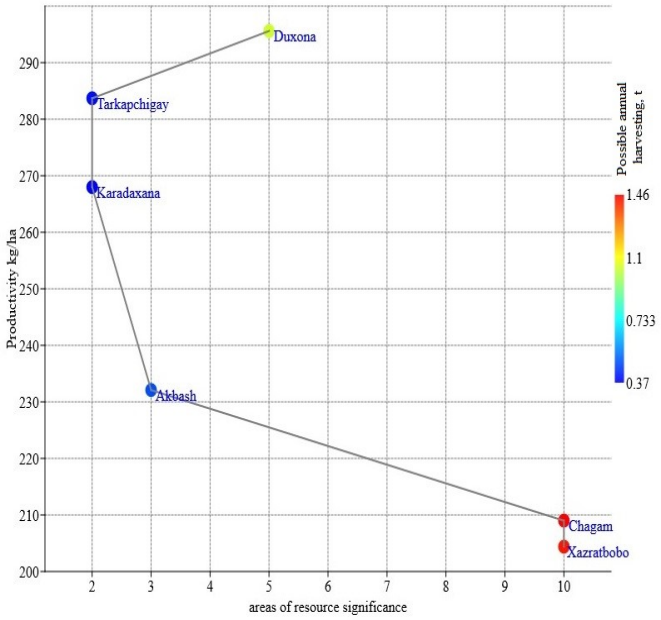



**Fig. 6.** Reserves of underground phytomass *Inula grandis* in Southern Uzbekistan.

## Discussion

According to one report, *Inula grandis* is widespread at altitudes of 800-2000 m above sea level in meadow-steppe soils, forming fairly dense thickets in the territory of the Surkhandarya region (4). The phytocenotic optimum lies within the altitude range of 1200-1800 m above sea level; its groups are distributed among the communities of the Turan dry forb steppe, deciduous forests, juniper forests and high-mountain large grass vegetation (4).

In our studies, at altitudes of 800-2000 m above sea level, *Inula grandis* was recorded on all types of soils, only in single specimens or groups, forming sparse thickets such as tall grasses. The optimum location for soil types and altitude above sea level is the mountain-crushed soils of Lithosols (I) at altitudes of 1300-1500 m above sea level. The phytochenotic optimum is widespread in the forb-shrub-juniper community (Fig. 7).

The yield of underground phytomass in the Kashkadarya region averages 261.2 kg/ha and in the Surkhandarya region, 236.3 kg/ha. Possible annual harvesting depends on the areas of resource value of the plants. Since the main areas of commercial thickets are distributed at altitudes of 1300-1500 m above sea level. These indicators correlate with specimens of productive maturity of plants on 10 x 10 m survey plots (Fig. 8).

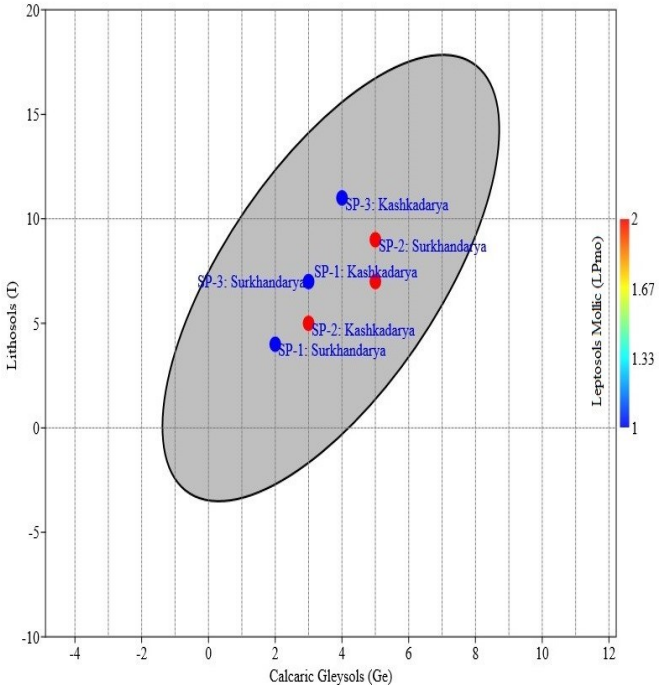



**Fig. 7.** Abundances (%) in phytocenoses of *Inula grandis* on different soil types.

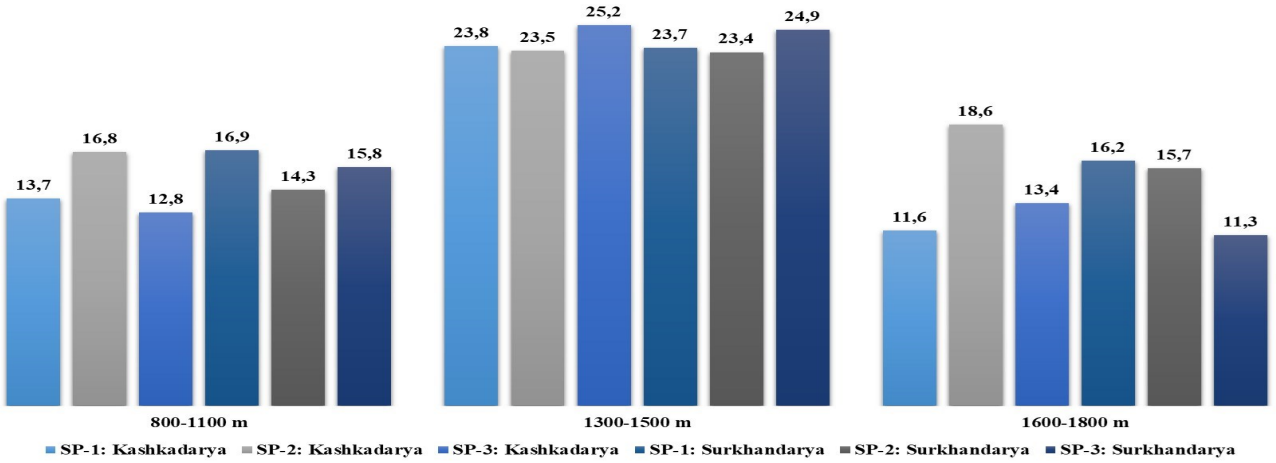



**Fig. 8.** Average indicators of *Inula grandis* individuals at monitoring sites (10 x 10 m).

## Conclusion

The edaphic optimum distribution of *Inula grandis* in southern Uzbekistan is the mountain-crushed soils of Lithosols (I) at altitudes of 1300-1500 m above sea level. The phytochenotic optimum of the plant is a forb-shrub-juniper community.

The yield of underground phytomass *Inula grandis* in southern Uzbekistan averages 248.7 kg/ha. The volume of possible annual harvesting is 5.16 tons from 32.0 ha of resource areas.

In order to rationally use the biological resources of *Inula grandis* in Southern Uzbekistan, it should be carried out in thickets with good vitality, high seed renewal and yield of rhizomes with roots in the zone of 1300-1500 m above sea level. It should be noted that repeated harvesting of plant roots can be carried out in the same place after 4-5 years.

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## Authors' contributions

All the authors together conducted fieldwork, data collection, data analysis, data generation and manuscripts. All authors read and approved the manuscript.

## Compliance with ethical standards

**Conflict of interest:** The author declares that the provided information has no conflict of interest.

**Ethical issues:** None

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