

## STUDIES ON THE ROOT ANATOMY OF RUBBER PRODUCING ENDEMIC OF KAZAKHSTAN, *TARAXACUM KOK-SAGHYZ* L.E. RODIN

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### ABSTRACT

This paper highlights morpho-metric and anatomical characteristics of a rare, endangered, endemic species *Taraxacum kok-saghyz* from Kazakhstan. The plant has been investigated using three different populations during young generative stages. The morphometric features recorded here from the natural populations show that, height of *T. kok-saghyz* plants and diameter of crown significantly increase in generative period. Plant roots contain milky tubes filled with coagulated latex - rubber threads, and are characterized by varying degrees of specific tissue development, depending on place of growth. Thus, it was found that plants of population № 2 are characterized by significant development of primary cork (553.12 mkm=micron) and diameter of central cylinder (432.70 μ), in which narrow clearance xylem elements are concentrated. On the contrary, plants of population № 3, have all signs of body xeromorphic structures (strong development of cover tissue and presence of more wide clearance vessels of water conducting tissue). Dark chestnut mountain soil type is the most favorable for plant growth and development. This taxon is a hygrophilous plant therefore water supply conditions affect distinctive features of plant internal structure.

**Keywords:** *Taraxacum kok-saghyz*, Anatomy, Rare/endemic species, Kazakhstan.

### INTRODUCTION

*Taraxacum kok-saghyz* known as *kok-saghyz* or "Russian dandelion" is an efficient rubber producer with the same qualities as *Hevea brasiliensis* (Lobanov, 1951). It is one of the rare plant species facing a risk of extinction due to human interferences, because the extraction of natural rubber from the plant is continuing from decades. The *kok-saghyz* root (in dry condition) contains 76 percent of rubber (chloroform extract), 35.9 percent of soluble carbohydrates (mainly inulin), 25 percent of resin, 54 percent non rubber components (lignin, protein, fiber) (Dogadkin, 1947; Volis *et al.*, 2009). The rubber is present in the young latex tubes in the form of latex (latex juice) and in older roots, it is in the coagulated form of fiber concentrated in the root bark. It is also valuable due to the concentration of natural polysaccharide inulin-natural carbohydrate (Gilyarov *et al.*, 1986).

During the Soviet regime from 1930 to 1940 dandelion *kok-saghyz* attracted much attention as one of the domestic rubber-bearing plants, with roots containing an average of 3-10,6 percent of rubber which could serve as raw material for its production. This interest towards *kok-saghyz* was more uplifted during the Second World War, when supplies of rubber produced from *Hevea brasiliensis* to Europe and the US were stopped. Therefore, many countries started searching alternative domestic natural resources in this direction.

However, from 1950 onwards the imports of natural rubber from *hevea* increased and at the same time due to the development of artificial rubber synthesis technology, cultivation of dandelion *kok-saghyz* decreased. Currently, due to growing demand for hypoallergenic natural rubber, scientists are again interested in *T. kok-saghyz* as a source for its production (van Beilen and Poirier, 2007; Mayhood, 2008; Wahler *et al.*, 2009; Baitulin, 2010; Kirscher *et al.*, 2013).

Currently *kok-saghyz* is included in "The Red Data Book of Kazakhstan" as a plant with declining stocks due to the extraction of natural rubber. According to the official decree of "The Republic of Kazakhstan" № 1046 dated July 9, 2009, the number of collecting dandelion *kok-saghyz* has been limited to only 750 roots for scientific purposes (Ydyrys *et al.*, 2014; Akhmetova *et al.*, 2015).

This taxon is also recorded as a rare endemic species of Kazakhstan, with its natural habitat limited to a small territory covering an area of 10 000 km<sup>2</sup> in inter mountain valleys (local name "syrt") at altitudes varying between 1800-2100 meters above sea level in the eastern Tien Shan (Trans-Ili, Kungey and Terskey Alatau, Ketmen ridge). It grows in saline meadows, among the pebbles, alongside the mountain river valleys and on the northern slopes of mountains.

Many scientists have conducted studies on the biological characteristics of *kok-saghyz* *ex situ* and *in situ* (Volis *et al.*, 2009; van Dijk *et al.*, 2010; Baitulin *et al.*, 2011; Ametov *et al.*, 2015; Mukhitdinov *et al.*, 2015). In

this study, our aim was to investigate the diagnostic features, as well as the changes occurring depending on the habitats of natural populations of *T. kok-saghyz*.

## MATERIALS AND METHODS

A total of three populations of *Taraxacum kok-saghyz* L.E. Rodin were recorded from the Almaty region of Kazakhstan (Fig. 1).



Figure 1. Location map for the three studied populations of *Taraxacum kok-saghyz*

Population №1 was located near Tuzkol lake, on alluvial-meadow soil, with a slightly sloping terrain valley to the lake, coordinates: N 43000.865/, E 079058.781/, altitude above sea level 1973 m. Population №2 was described in the surroundings of Kainar village, on dark chestnut mountainous soil, terrain is flat (intermountain valley), coordinates: N 42051.332/, E 079053.264/, altitude above sea level 1823m. Population №3 occurs at the foothills of mount Labasa, with a flat terrain (mountain valley), the soil is dark chestnut, coordinates: N 42°56.714', E 079°36.811', altitude above sea level 1886 m.

Research on cenotic populations was carried out following traditional methods outlined by Uranov (1973) and Rabotnov (1978). Since *T. kok-saghyz* contains rubber in latex tubes located in root bark, anatomical features of root were investigated according to the method outlined by Barykina (2004), and comparative analysis of morphometric data depending on the location and population growth was undertaken. Micrographs of

anatomical sections were studied on microscope MC 300 with camcorder CAM V400/1.3M.

## RESULTS AND DISCUSSION

1 m<sup>2</sup> selected sites were allocated in each *T. kok-saghyz* population, and on each site all specimens of this species were recorded, and main biometric indices measured. In all three *kok-saghyz* populations, vegetation was heavily stressed due to overgrazing of livestock. *T. kok-saghyz* population density analysis showed highest density of *kok-saghyz* specimen in population №3 (47.1 pieces / m<sup>2</sup>). Density of population №1 and №2 was approximately same, being 42.2 and 42.7 plants / m<sup>2</sup> respectively.

Young generative specimens of *T. kok-saghyz* are characterized by emergence of 1 - 2 peduncles with length from 2.5 to about 12.0 cm, plant height increased to 3 - 5 cm, crown diameter also increased to 5.8 - 10.0 cm, and quantity of leaves almost has not changed and was 9-11 (Fig. 2).

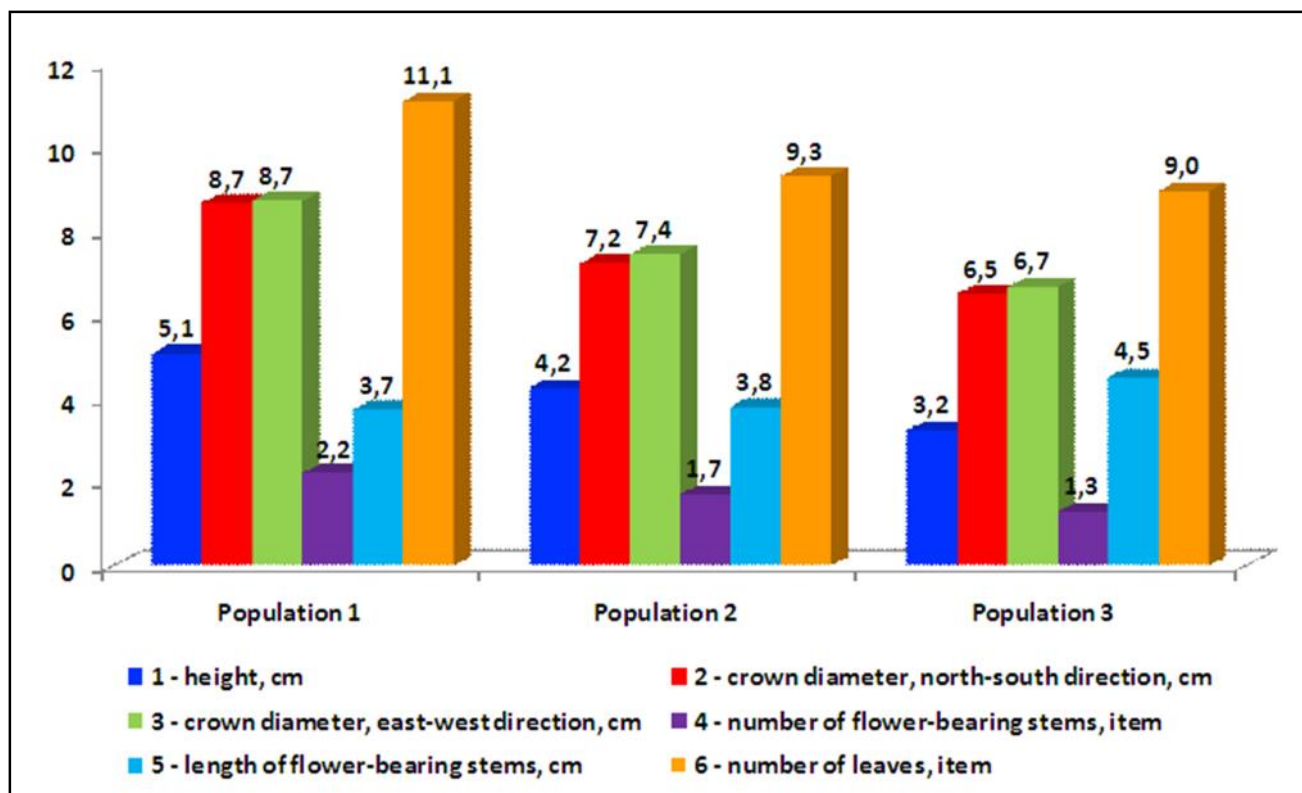


Figure 2. Morpho-metric parameters of *Taraxacum kok-saghyz* young generative plants

Anatomical characteristics of *T. kok-saghyz* plant root: A cross-section of perennial root of kok-saghyz is shown in figure 3. It has xylem, phloem, cambium, bark parenchyma, formed in the last year of vegetation, with the inclusion of latex tubes filled with latex and a layer of investing tissue. In cross section all root forming tissues are arranged in concentric circles.

On outside woody root of *T. kok-saghyz* is covered with a well-developed periderm, consisting of phellem, phellogen and phelloderm. Cells of peridermal layer are flattened, and have tabular form. On root cross-section the cells are arranged in regular rows in multiple

layers, and have a dark colour. Parenchyma cells of primary cortex are located under periderm with well expressed an inter-cellular spaces.

Latex tubes filled with coagulated latex-rubber threads, surrounded by remnants of bark parenchyma are located among parenchymal cells of the primary root bark in concentric circles. The diameter of latex tubes increases from the root center to root periphery. The number of dead layers of latex tubes and investing tissue depends on root age and corresponds to the number of its vegetation (Fig. 3).

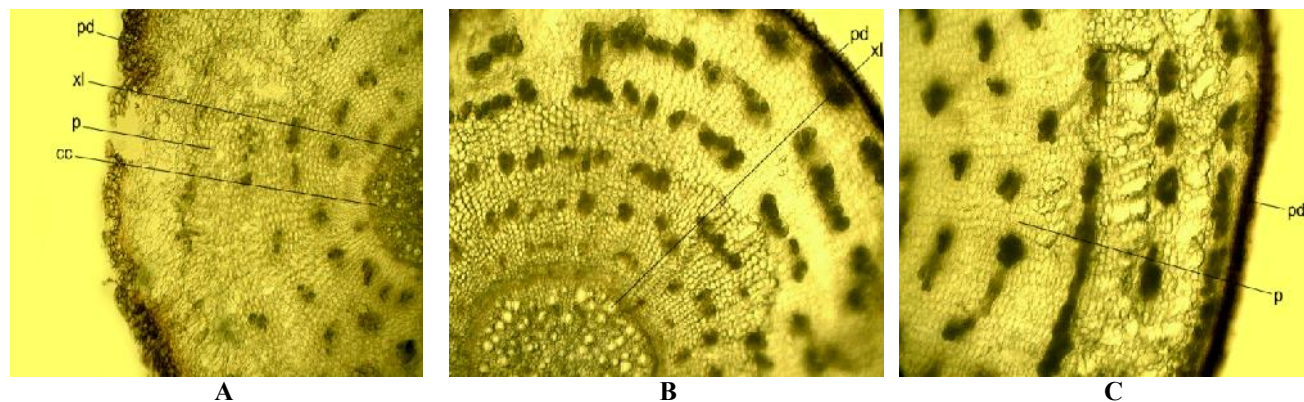


Figure 3. Anatomical structure of *Taraxacum kok-saghyz* root. (A) Population №1. (B) Population №2. (C) Population №3. (pd) Periderm. (sb) Secondary bark. (x) Xylem

The center of root is occupied by elements of conductive tissues and has a circular shape in cross section. Xylem in cross section is located radially and has a star-like shapes, its strands go in rays from primary xylem elements located in the root center and surrounded by sclerenchyma cells.

Xylem and surrounding tissues lack latex tubes and contain no rubber. During morphometric analysis of *T. kok-saghyz* root structure, it was found that the specimens of population № 2 are characterized by significant development of primary bark (553.12  $\mu$ ) and diameter of the central cylinder is 432.70  $\mu$ , in which root conductive elements are concentrated (Table 1). These figures are almost twice higher than similar figures in plants that form population № 1 and № 3.

Plants in population № 2, as well as in population № 1, are characterized by the availability of more narrow gap water conducting elements (10.02 and

11.10  $\mu$  respectively) compared to population № 3 (16.11  $\mu$ ). However, along with this, specimens of population № 2 have highly developed primary root bark, main part of which consists of live thin-walled parenchyma cells. This fact is important, because in addition to the function of synthesis and substance reserve, primary bark parenchyma also performs functions of conducting water and minerals in radial direction (from the root surface to central cylinder), i.e., it provides an additional water supply of plant root internal tissues.

On the contrary, when compared with the values of other population plants, *T. kok-saghyz* plants, comprising population № 3, have most developed investing tissue (71.07  $\mu$ ). Plant roots in the population № 3 are also characterized by the presence of more wide gap xylem vessels (16.11  $\mu$ ) (Table 1).

**Table 1. Morphometric indices of *Taraxacum kok-saghyz* root.**

Population	Periderm thickness, $\mu$	Primary cortex thickness, $\mu$	Central cylinder diameter, $\mu$	Xylem vessel diameter, $\mu$
1	69.59 $\pm$ 2.85	336.47 $\pm$ 8.67	188.23 $\pm$ 9.42	10.02 $\pm$ 0.39
2	67.18 $\pm$ 14.83	553.12 $\pm$ 33.72	432.70 $\pm$ 6.20	11.10 $\pm$ 0.30
3	71.07 $\pm$ 1.81	304.11 $\pm$ 8.02	258.89 $\pm$ 1.12	16.11 $\pm$ 2.72

Based on these figures we can conclude that plants forming population № 3, have a more xeromorphic features. Cork tissue provides not only gas exchange and thermal insulation function, but also protects internal tissues from drying out. In turn, conductive tissues, in particular xylem vessels, are the main elements of conductive tissue, which are responsible for conducting water with dissolved minerals. During the moisture shortage, plants have to use each milliliter of both soil and atmospheric moisture, by increasing conducting vessel diameter.

**Conclusions:** Our investigations on the root internal structure of *T. kok-saghyz* collected from three different populations, have revealed the following conclusions:

1. The morpho-metric characteristics in natural populations of *T. kok-saghyz* have shown that in the generative period the height of *T. kok-saghyz* plants significantly increases, their crown diameter, peduncles emerge, but quantity increases in the average generative stage. Practically, the height of peduncles and quantity of leaves does not change.

2. The studies on root internal structure of three different populations of *T. kok-saghyz* has enlightened the fact that the plants; regardless of their place of growth; have a similar anatomical structure of the ground bodies investigated, namely, they are characterized by woody roots of secondary structure, and have some main differences of quantitative characters.

3. The morphometric analysis has depicted that growth conditions are most favorable for plant growth and development in population №2, as the place of growth of this population is characterized by the presence of dark-chestnut mountain soil type with a thick layer of black soil. The best soils for *T.kok-saghyz* are heavy, common and leached black soils that have an impact on plant growth and development specific to population №2.

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