

Seed productivity and dynamics of germination of *Ziziphora* L. species in the Pamir-Alay

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Abstract. Seed productivity of 4 *Ziziphora* species: *Z. pamiroalaica*, *Z. interrupta*, *Z. brevicealyx*, and *Z. suffruticosa* growing in the Pamir-Alay Mountains was studied. It was revealed that the indicator of real seed productivity did not exceed 40 %. Seed viability and character of germination were studied. It was established that seeds of all species did not have a dormancy period, had high viability, up to 95 % and high germination energy.

1 Introduction

Seed productivity is one of the important indicators of species vitality in different living conditions [1]. It governs a species role in the phytocoenosis and expresses plant adaptation to environment conditions [2, 3]. Study of seed productivity is widely considered in modern literature [4-6].

Ziziphora representatives dominate in the plant cover of the Pamir-Alay and form in the high mountains the florocoenotype “thyme communities” characteristic of Central Asia, they grow on stony-cobble slopes and screes from the low to the high mountains [7, 8]. The species are widely used as medicinal plants [9] and are overharvested in the wild, which leads to population depletion. Study of seed productivity and seed germination will allow to reveal mechanisms of adaptation and sustainable development of species in various communities of the montane belt Pamir-Alay. In this regard the aim of the paper was study of seed productivity and seed germination of 4 *Ziziphora* species growing in the Pamir-Alay Mountains.

2 Material and methods

The material on seed productivity of 4 *Ziziphora* species was collected in 2016-2017 in the territory of Mogoltavsky and Gissaro-Darvazsky floristic regions of the Pamir-Alay (Tajikistan): 1. *Z. pamiroalaica* Juz. – Gissarsky Range, gorge of the Varzob river, vicinities of Ziddi vilage, 2800 m above sea level, tall herbage semisavanna, pebble-clayey

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slope; 2. *Z. interrupta* Juz. – Karateginsky Range, gorge of the Ramit river, vicinities of Zairon, 1200 m above sea level, shibliak, stony slope; 3. *Z. brevicealyx* Juz. – Khozrati-Shakh Range, vicinities of Lyangar village, 2200 m above sea level, thermophilous juniper stand, pebble-clayey slope ; 4. *Z. suffruticosa* Pazij et Vved. – Mogol-Tau, gorge of the Muzbek river, 800–900 m above sea level, shibliak, stony-pebble slope.

Generally accepted procedure [10,11] was used for determination of potential (PSP) and real (RSP) seed productivities and productivity coefficient (C) for a shoot in 50 mature generative individuals. Seeds were germinated in Petri dishes, 100 pieces each, in 3-fold replication at room temperature 20-24 °C for 10 days. Germination rate was expressed by the number of seeds germinated per day as a percentage of the total number of seeds germinated for 10 days. Data were treated with the use of STATISTICA 10.

3 Results and discussion

The species are similar in inflorescence structure – this is a capitate thyrse consisting of numerous opposite-arranged dichasia. A flower gynecium contains 4 ovules. *Ziziphora* flowers are entomophilous, their efflorescence is acropetal (from the flowers in the lower part of the inflorescence to the flowers in the upper part). In this regard seed ripening in inflorescences is stretched in time. *Z. interrupta* has a many-flowered inflorescence, the number of flowers in it is 1.5–2 times greater compared to the other species (Table 1), in this regard its PSP is also higher. Despite growth in different ecological-phytocoenotic conditions, the index of seed setting of the species does not differ and averages 1.4–1.6 seeds per fruit. Real seed productivity ranges from 31 to 71 seeds per inflorescence. However, the coefficient of productivity, an indicator of species reliability and wellbeing, does not exceed 40% in the species under study.

Table 1. Seed productivity of 4 *Ziziphora* species

Species	PSP		RSP		c. %
	Number of flowers in inflorescence	Number of ovules in inflorescence	Number of seeds in coenobium	Number of seeds per inflorescence	
<i>Z. brevicealyx</i>	20.9±1.07	83.7	1.5±0.5	31.4	37.5
<i>Z. interrupta</i>	44.9±2.66	179.5	1.6±0.7	71.8	40.0
<i>Z. suffruticosa</i>	32.7±1.52	130.9	1.6±0.6	52.3	39.9
<i>Z. pamiroalaica</i>	29.1±1.34	116.6	1.4±0.5	40.8	35.0

A fruit of the species under study – coenobium represents a fractional box in which there are 4 seeds. At disintegration of the box, erems in which there is one seed are formed. An erem coat grows together with that of a seed [12]. Seeds are ovate, oblong-ovate, glabrous or tubercular. Erem colour (seed) is light brown, greyish-brown, seldom brown. The largest seeds are noted in *Z. pamiroalaica*, mass of 1000 seeds is almost 1.5 times greater than in the other species. Distinctions are also observed in size, values of length and width of *Z. pamiroalaica* and *Z. brevicealyx* seeds differ significantly from those of the other two species (Table 2). Seeds in the experiment swell very well and germinate better at the light than in the dark. Swelling process does not depend practically on the temperature of the germination medium and completely comes to an end in 1-2,5 days since the moment of moistening. Good water permeability of seed coats of *Ziziphora* species indicates absence of physiological dormancy and excludes necessity of scarification. Laboratory germinating ability of seeds of three species amounts to 93–95%, it is somewhat lower in *Z.*

pamiroalaica – 88%. On the whole, germination percentage is very high (Fig. 1), which indicates superior quality of the species seed.

Table 2. Morphometric indices of *Ziziphora* species seeds

Species	Morphometric indices			
	Length, mm	Width, mm	Length/width	Mass (1000 seeds), mg
	M ± m	M ±m		
<i>Z. brevicalyx</i>	1.5±0.02	0.7±0.01	2.2±0.04	0.319±0.001
<i>Z. interrupta</i>	1.4±0.01	0.6±0.01	2.3±0.03	0.302±0.001
<i>Z. suffruticosa</i>	1.3±0.01	0.6±0.01	2.2±0.04	0.298±0.001
<i>Z. pamiroalaica</i>	1.7±0.02	0.7±0.01	2.4±0.03	0.402±0.002

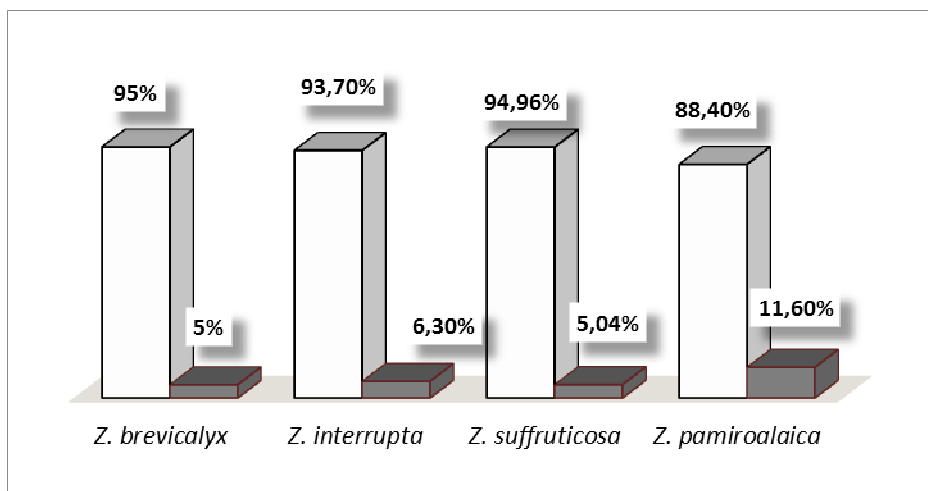


Fig. 1. Laboratory germinating ability of seeds of 4 *Ziziphora* species.

Designations: □ – germinated, ■ – died off.

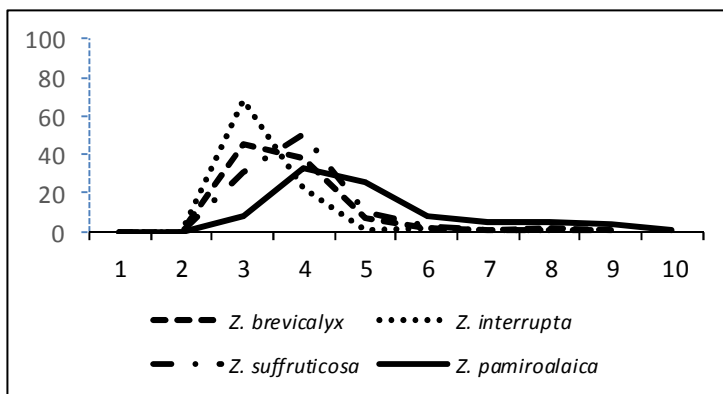


Fig. 2. Dynamics of seed germination of *Ziziphora* species at 20-24°C.

Designations: on the abscissa axis – days of germination, on the ordinate axis – number of germinated seeds.

Single-vertex curve of seed emergence rate (Fig. 2) with the maximum on the 3-d and 4-th days of the experiment is typical of the species. *Z. interrupta* seeds germinate faster all, 68 % of seeds germinated already on the 3-rd day, the main quantity of *Z. suffruticosa* and *Z. brevicalyx* seeds emerged for 2 days and accounted for 91 и 90 %, respectively. Extended germination during 7 days was noted only in *Z. pamiroalaica*. Such a character of seed germination is connected with growth conditions of the species. The first three species grew in the lower and middle belts of the mountains at an altitude of 800-2200 m above sea level in the arider conditions in the shibliak belt, and *Z. pamiroalaica* – at an altitude of 2800 m and higher above sea level in more humid conditions in the belt of semisavanna tall herbage.

High germinating ability and multiplicity of generative shoots compensate a low figure of the coefficient of inflorescence seed productivity. This makes it possible to maintain stability of populations in different montane belts of the Pamir-Alay. However, a short period from swelling to beginning of germination and high seed emergence rate at sharp fluctuations of weather conditions may adversely affect further existence and development of young plants.

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