Roczniki Akademii Rolniczej w Poznaniu – CCCLXIII (2004)

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PRELIMINARY STUDIES ON SEED GERMINATION AND CHANGES IN FOLIAGE OF *LYSIMACHIA VULGARIS* L. IN GARDEN CULTURE

Z Katedry Botaniki
Akademii Rolniczej im. Augusta Cieszkowskiego w Poznaniu

ABSTRACT. The evaluation of the viability and germination capacity of *Lysimachia vulgaris* L. seeds under garden cultivation conditions was done and the study on different number of leaves in whorls on shoots of *L. vulgaris* was performed. Germination capacity of the examined seeds ranged from 2.8% to 52.6% and differed significantly in dependence of the sowing time, germination conditions and the fact whether or not the seeds underwent the stage of vernalization. *L. vulgaris* plants with different number of leaves in whorls propagated generatively and vegetatively did not have the same number of leaves on their offspring. Plants with two leaves in whorls were most numerable (60.0-70.0%), three laves in whorls were observed on approx. 30.0% and four leaves on approx. 13.0% of the offspring.

Key words: *Lysimachia vulgaris*, yellow loosestrife, seeds, germination, foliage

Introduction

Lysimachia vulgaris L. – yellow loosestrife (*Primulaceae*) is a species occurring in the whole Eurasia, from the Great Britain to Japan, excluding the part of Europe furthest to the north, southern Spain and Greece. It grows rather rarely in Italy and the occurrence of this species in Albania requires confirmation (**Hegi** 1965, **Valentine** and **Kress** 1972). In Poland it is common throughout the country, it is found in fens, wet meadows, ditches, lake-shores, river banks and wet woods (**Broda** and **Mowszowicz** 1996, **Zając** and **Zając** 2001). It is one among other aquatic macrophytes, which are valuable as indicators of water quality (**Samecka-Cymerman** and **Kempers** 2001).

Lysimachia vulgaris is a stolonate perennial with a creeping rhizome. It propagates vegetatively by the rooting of the stolones and also generatively by seeds. It is a species of a great morphological differentiation, also with reference to foliage, which, according to the morphological descriptions, is opposite or verticillate with three-four almost sessile, red-brown spotted leaves (**Pawłowski** 1963, **Valentine** and **Kress** 1972).

Rocz. AR Pozn. CCCLXIII, Bot. 7: 201-207

PL ISSN 1508-9193

The aim of this study was to evaluate the viability and germination capacity of *Lysimachia vulgaris* seeds. The further aim was to explain whether and if so, to what extent the trait of the varied number of leaves in the whorls is repeated in the offspring generations of yellow loosestrife propagated generatively and vegetatively.

Material and methods

The investigations were conducted on the basis of three-year observations on plants growing in garden culture. In the first year of the study plants for the investigations were selected in a natural population located in the ecological area "Flood meadows on the Obra River". A total of 30 plants each were selected with two, three and four leaves in the whorl, from which plant material was collected for the purpose of vegetative and generative propagation. The selected plants were spread at the distance of at least 5 m from each other. The garden culture of *L. vulgaris* was established from seeds collected from the previously selected plants, and from stolones of these plants, which were dug out and transferred to the garden. The underground organs were collected each time from 15 plants with the different number of leaves in the verticils. In September of the same year a total of 150 seeds from each plant were sown directly to the ground and to cases with a mixture of peat and sand in the proportion of 1:1, in three replications of 50 seeds. The cases with seeds were left outdoors throughout the winter, at the end of March of the following year they were transferred to the glasshouse with balanced temperature of 20-25°C and were watered uniformly. Seeds coming from plants with two leaves in the verticil were denoted as combination *A*, those with three leaves as combination *B*, and those with four leaves as combination *C*.

Underground organs of plants were planted at the same time, as the seeds were sown. Plants were grown at the spacing of 1 m.

In the second year of the study, in the middle of April, seeds, which during the winter had been stored at room temperature and under air flow conditions, were sown, in the same way as previously, to cases in the glasshouse. Seeds used in the spring sowing were marked identically as those for the autumn sowing as A_1, A_2 and A_3.

Prior to the sowing the viability of the seeds was determined using the tetrazolium test according to the ISTA recommendations for species of the family *Primulaceae* (Handbook... 1985). The test was carried out in two replications of 50 seeds. In each seed one third of the seed – parallel to the hilum – was removed, the moistening time was 18 h, staining time was 48 h at 30°C.

Observations of the seeds sprouting were conducted for two months, every two weeks. The significance of differences in seed germination capacity depending on the sowing dates was determined using the Student–*t* Test.

In the second year of the investigations, in September, the produced seedlings from the seed-plot were planted in the ground at the spacing of 1 m, with 30 plants for each combination. The plants were well-rooted, 10-20 cm high and with two-three developed leaf whorls. The number of leaves in the whorls on individual plants propagated generatively was determined in the following years of the study during plant blooming.

In case of plants grown from vegetative organs transferred from the natural populations to the garden culture, the number of leaves in the verticil on shoots of individual plants were determined also at the blooming stage.

Results

The embryo in loosestrife seeds is straight, located in the middle of the seed, surrounded by a nuclear, oily endosperm (**Netolitzky** 1926, **Corner** 1976, **Takhtajan** 1992). After the tetrazolium test, the longitudinal sections were done. Seeds with the embryo and the endosperm tissue apart from the embryo completely stained were accepted as viable. The test showed that 85.0% of the examined seeds were viable.

Seeds that underwent the vernalization stage started germinating two weeks after cases were transferred to the glasshouse. In the following observations a total of 34.8% seeds germinated in combination *A*, 43.6% in combination *B* and 52.6% in combination *C*. Seeds sown directly to the ground germinated in very limited numbers. In case of seeds collected from plants with two leaves in the verticil a total of 4.2% seeds germinated, those with three leaves – 3.2%, whereas in case of those with four leaves – 2.8%. Seeds sown to cases in the glasshouse in the spring season, with no stratification, started germinating five weeks after sowing and the percentage of germinating seeds from individual combinations was 26.0%, 30.0% and 14.0%, respectively. Differences in the mean number of germinated seeds, which were sown to cases in the autumn and in the spring, amounted to 8.8%, 13.6% and 38.6%, respectively. Found differences were statistically significant ($t_E = 4.72$ for the critical test value $\alpha_{0.05} = 2.10$).

On all the seedlings grown from the sown seeds two leaves in the verticals were observed, irrespective of the plants from which the seeds originated. In the second year of vegetation all the plants grown from seeds in combination *A* had two leaves in the verticil, whereas in plants from combinations *B* and *C* it was found that 13.3% and 20.0% specimens had three leaves in the whorl. Moreover, in combination *C* in 13.3% plants four leaves were observed in the whorl (Table 1). In the same year of the study plants propagated vegetatively had from one to three shoots, on which in combination *A* two leaves in the verticil were found in 60.0% plants, in combination *B* in 53.3%, and in combination *C* in 33.3% plants. In each combination a considerable percentage of plants, ranging from 33.4% to 60.0%, was observed with three leaves in the whorls, and a slight, between 6.6 and 13.3%, share of specimens with four leaves in the verticils (Table 1). In the course of the conducted observations 10 plants were found, which on individual shoots growing from one plant, i.e. consisting a clone, had different numbers of leaves in the whorls. Since the investigated species exhibits a fast rate of stolones growth, in order to avoid errors resulting from the evaluation of shoots from other clones, only shoots growing in the immediate vicinity of the site where a given specimen was planted were taken into consideration (Table 2). On two plants on the same shoot two leaves in the whorl were observed in the lower segment of the stem, whereas in the upper parts of the stem the whorls had three leaves.

Discussion

It resulted from the conducted investigations on the germination of *Lysimachia vulgaris* seeds that in spite of their high viability only a small number of seeds sown directly to the ground germinated. The very small percentage of germinating seeds could be, on the one hand, the effect of environmental conditions (temperature, humidity, light,

Table 1

Variability in the number of leaves in the whorls on shoots of *Lisymachia vulgaris* plants propagated generatively and vegetatively
Zróżnicowanie liczby liści w okółkach na pędach roślin *Lisymachia vulgaris* rozmnożonych generatywnie i wegetatywnie

No. of plant Nr rośliny	Combination – Kombinacja																	
	A (from plants with two leaves in whorl) *A* (z roślin o dwóch liściach w okółku)						*B* (from plants with three leaves in whorl) *B* (z roślin o trzech liściach w okółku)						*C* (from plants with four leaves in whorl) *C* (z roślin o czterech liściach w okółku)					
	observed number of leaves in whorl – obserwowana liczba liści w okółku																	
	2		3		4		2		3		4		2		3		4	
	G	V	G	V	G	V	G	V	G	V	G	V	G	V	G	V	G	V
1, 2	+, +	+		+			+, +	+, +					+, +			+, +		
3, 4	+, +	+		+			+, +			+, +					+, +	+, +		
5, 6	+, +	+		+				+	+, +			+		+, +			+, +	
7, 8	+, +	+, +					+, +	+				+		+	+, +	+		
9, 10	+, +	+		+			+, +	+, +					+, +			+, +		
11, 12	+, +	+		+			+, +	+		+			+, +	+, +				
13, 14	+, +	+, +					+, +	+		+			+, +			+, +		
15, 16	+, +					+	+, +			+			+, +					+
17, 18	+, +						+, +								+, +			
19, 20	+, +								+, +								+,+	
21, 22	+, +						+, +						+, +					
23, 24	+, +						+, +						+, +					
25, 26	+, +						+, +						+, +					
27, 28	+, +						+, +						+, +					
29, 30	+, +						+, +						+, +					
Total Suma	30	9		5		1	26	8	4	5		2	20	5	6	9	4	1
%	100.0	60.0		33.4		6.6	86.7	53.3	13.3	33.4		13.3	66.7	33.3	20.0	60.0	13.3	6.7

G – plants propagated generatively, V – plants propagated vegetatively.
G – rośliny rozmnożone generatywnie, V – rośliny rozmnożone wegetatywnie.

Table 2
Variability in the number of leaves in whorls on shoots of *Lysimachia vulgaris* consisting a clone
Zróżnicowanie liczby liści w okółkach na pędach *Lysimachia vulgaris* stanowiących klon

No. of plant Nr rośliny	Combination Kombinacja	No. of shoots in a plant Liczba pędów na roślinie	No. of leaves on each shoot Liczba liści na poszczególnych pędach
1	*A*	2	2, 3
2	*B*	2	2, 3
3	*B*	2	3, 4
4	*B*	2	2, 3
5	*C*	2	2, 4
6	*C*	2	3, 4
7	*C*	3	2, 3, 3
8	*C*	3	2, 3, 4
9	*C*	2	2, 3
10	*C*	2	2, 3

the depth and spacing of sowing), and on the other hand – the effect of seed dormancy, which is a typical trait of numerous wild plant species from the temperate region (**Baskin** and **Baskin** 1988). The fact that seeds of the investigated species after ripening become dormant and do not germinate, or germinate at much lower intensity is indicated also by the significant differences, which were found in the conducted investigations, concerning the number of germinating seeds depending on the fact whether or not they underwent the stage of vernalization. **Falińska** (1981) showed that seeds of yellow loosestrife from the soil seed bank investigated for the alder swamp community did not germinate in the laboratory experiment. The same author found the occurrence of *L. vulgaris* seedlings only after the experiment had been conducted on the germination capacity of seeds remained in the soil, which was stored for one season in the garden. After the soil had been kept in the garden for three years, seeds of the investigated species did not germinate. Observed in this study low germination capacity of the examined seeds confirms the results of the studies on the ecological succession in meadow communities (**Falińska** 1991), showing that the investigated species, although exhibiting both methods of propagation, is spread primarily as a result of vegetative reproduction. *L. vulgaris* is a species with iterative growth, included among the polycormous plants with a short-term shoot community, which is the effect of the delicate structure of their stolones. Specimens originating from seeds rarely appear in natural populations and generative propagation is only supplementary in character.

The conducted investigations showed that the trait of the different number of leaves in the verticils on the shoots of yellow loosestrife grown from seeds is not transmitted to the next generation of plants. Plants propagated vegetatively and constituting one clone also showed in the following generations diverse numbers of leaves in the verticils. It results from autecological studies on various plant species that the diverse number of leaves in the whorls and on a whole plant is one of the traits reflecting the size and habit of the investigated specimens and the degree of its variability is frequently determined

by the environmental conditions of the compared populations (**Marczonek** et **al.** 1989, **Mróz** and **Sarosiek** 1993, **Mróz** 1994, **Czarnecka** 1995, **Wożakowska-Natkaniec** 1998). The level of variability in the number of leaves in plant is manifested in the coefficient of variability given in the cited studies, the value of which is most frequently approximately 15.0-25.0%.

Changes in foliage observed in the conducted investigations expressed by the number of leaves in the whorls are one of the morphological traits of yellow loosestrife indicating the considerable individual variability of the investigated species.

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WSTĘPNE BADANIA NAD KIEŁKOWANIEM NASION I ZMIANAMI W ULISTNIENIU *LYSIMACHIA VULGARIS* L. W KULTURZE OGRODOWEJ

S t r e s z c z e n i e

Przeprowadzono badania żywotności i zdolności kiełkowania nasion *Lysimachia vulgaris* L. oraz podjęto próbę oceny, czy i w jakim stopniu cecha zróżnicowanej liczby liści w okółkach jest powtarzana przez rośliny tojeści zwyczajnej rozmnożone generatywnie i wegetatywnie. Obserwacje prowadzono na roślinach rosnących w kulturze ogrodowej, którą założono z nasion zebranych z populacji naturalnych oraz z pobranych w terenie organów podziemnych wytypowanych osobników. Materiał roślinny wykorzystany do rozmnożenia pochodził z trzech form roślin mających po dwa, trzy lub cztery liście w okółku. Kiełkowanie nasion badano w zależności od terminu siewu, warunków kiełkowania oraz obecności lub braku stadium wernalizacji. Obserwacje nad ulistnieniem przeprowadzono na roślinach rozmnożonych generatywnie i wegetatywnie w dwóch kolejnych latach badań. Nasiona, które przeszły stadium wernalizacji i kiełkowały w wyrównanych warunkach szklarniowych, skiełkowały w 34,8-52,6%, a nasiona kiełkujące w gruncie w 2,8-4,2%. Nasiona, których nie poddano stratyfikacji, skiełkowały w 14,0-30,0%. Zaobserwowane różnice w kiełkowaniu nasion były statystycznie istotne. Na wszystkich siewkach, które wyrosły z wysianych nasion, obserwowano w pierwszych okółkach po dwa liście, bez względu na to, z jakich roślin pochodziły nasiona. W dalszych latach, w obrębie poszczególnych grup roślin rozmnożonych zarówno generatywnie, jak i wegetatywnie, stwierdzono występowanie osobników o zróżnicowanej liczbie liści w okółkach, przy czym roślin z dwoma liśćmi w okółku było od 33,0 do 100,0% w zależności od kombinacji, z trzema liśćmi od 13,3 do 60,0%, a z czterema liśćmi od 6,6 do 13,3%.

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