TRENDS OF CENTAUREA JACEA L. SEED PRODUCTIVITY

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The authors describe trends of Centaurea jacea L. (Asteraceae) seed productivity. Reasons for the seed productivity indicators change are analyzed. Main factors affecting the coefficient of seed productivity are identified.

Keywords: Centaurea jacea L., capitulum, seed productivity, seed productivity coefficient, biological control agents.

Conference participants,
National championship in scientific analytics,
Open European and Asian research analytics championship

For successful implementation of biodiversity maintenance it is essential to understand the trends of the species reproductive biology and its specificity of generative features that jointly with ecological factors provide with the seed productivity.

One of the most significant indicators that characterizes the adaptation level to the specific ecological conditions is the seed productivity study. Due to its results it can be determined the occurrence of rejuvenation process in the given population.

The aim of this research included the study of *Centaurea jacea* L. (Asteraceae) seed productivity trends, the analysis of the data received, the determination of the basic factors mostly affecting the seed productivity.

Methodology and object of research

The object of given research included four populations of *C. jacea* under different conditions of biogeocenosis usage mode:

Population I is situated on the mesophilous meadow of the south-west slope at the bank lake which enters in composition of association community of *Festucetum (pratensis) stenactiosum (annua)*, next to the arboretum "Druzhba" of the Vasyl Stefanyk Precarpathian National University, Ivano-Frankovsk.

Population II is growing on the open area of the dry mountain meadow which enters in composition of association community of *Agrostidetum (tenuis) festucosum (pratensis)* on the mountain Maliava, next to the village Dora, Nadvorna district, Ivano-Frankovsk region.

Population III is situated on the dry mountain meadow which enters in composition of association community of *Dactylus (glomerata) luzulosum (campestris)* at the Yablunitsa pass, in the south-west outskirts of the village Yablunitsa, Nadvorna district, Ivano-Frankovsk region.

Population IV is situated on the present bottomland meadow which enters in composition of association community of *Festucetum (pratensis) galiosum (palustre)*, on the river bank "Glubokii potok", in the south outskirt of the village Dubrava, Tiachev district, Zakarpattia region.

The seed productivity (SP) of the studied populations has been inestigated over a period of 2008-2010 by I. V. Vainagiy [1] methodology. The indices of potential seed productivity (PSP) and actual seed productivity (ASP) as well as the coefficient of the seed productivity (CSP) have been implemented for its description. The gathering was being carried out within the mass seeds ripening. The monocarpic generative branches of *C. jacea* was chosen as a primary registration unit.

Results and discussion

In the process of studying it has been established that the ripening of fruit in the capitulums of *C. jacea* occurs in the second half of August and is in progress till the end of September in all studied populations (fig. 1). The long-term process of

Table 1.

Level of variability of *Centaurea jacea* generative sphere quantitative variables in the studied populations

№ of populatn	Years Of reseah	Morphometric parameters					
		Number of capitulums in the specimen, pcs.		Number of side branches II-order, pcs.		Diameter of capitulum, cm	
		M ± m	V, %	M ± m	V, %	M ± m	V, %
1	2008	14,1 ± 0,45	25,21	5,0 ± 0,11	10,86	9,4 ± 0,17	8,91
	2009	9,3 ± 0,31	16,36	4,0 ± 0,12	15,43	9,4 ± 0,11	5,92
	2010	6,8 ± 0,15	10,51	4,7 ± 0,21	22,49	9,3 ± 0,11	6,01
2	2008	7,6 ± 0,20	12,68	2,9 ± 0,10	16,89	8,1 ± 0,15	9,52
	2009	6,9 ± 0,17	9,67	3,8 ± 0,22	28,80	8,6 ± 0,22	12,92
	2010	4,5 ± 0,12	8,56	2,9 ± 0,15	26,01	7,9 ± 0,24	15,25
3	2008	14,7 ± 0,43	27,02	6,5 ± 0,23	17,78	7,3 ± 0,22	15,34
	2009	7,1 ± 0,19	14,54	6,0 ± 0,25	21,38	6,8 ± 0,18	13,05
	2010	8,6 ± 0,24	18,32	6,9 ± 0,21	14,99	7,8 ± 0,31	19,69
4	2008	6,6 ± 0,16	15,75	4,9 ± 0,11	11,62	10,2 ± 0,15	7,54
	2009	8,8 ± 0,28	17,39	4,0 ± 0,25	32,17	10,0 ± 0,19	9,39
	2010	7,6 ± 0,14	11,47	4,9 ± 0,16	16,51	10,5 ± 0,18	8,59

Footnote: M - arithmetic mean; m - mean deviation; V – coefficient of variation, %

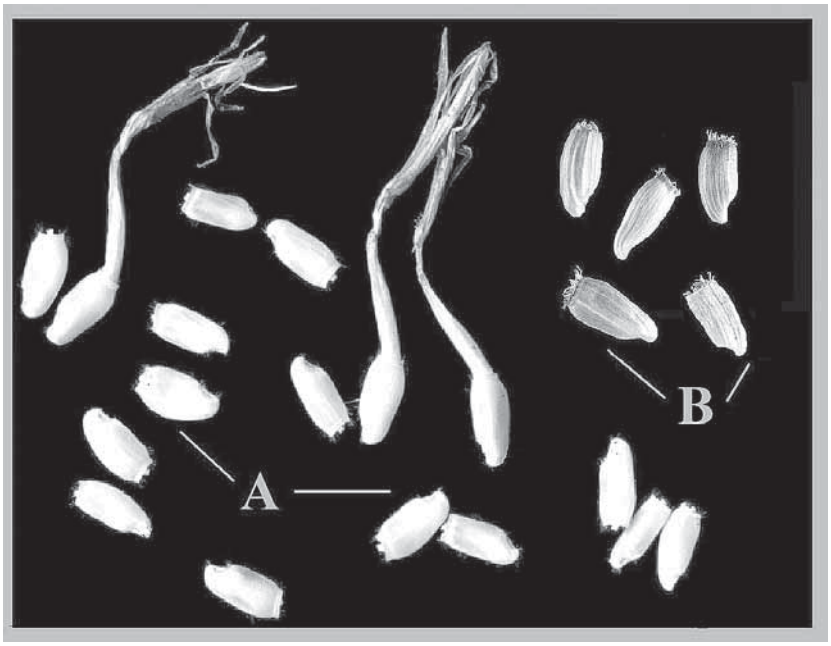

Fig. 1. Centaurea jacea appearance of seeds: A - milky ripeness; B - mature seed

fructification is connected with nonsimultaneous growth of tubular blooms in blossom cluster of *C. jacea* as well as with the rate of its fertilization.

The research results demonstrate that the diameter of the capitulum is the sufficiently persistent indicator (fig. 2) and has the insignificant percentage the variation (table 1) in all monitoring populations of *C. jacea*.

In the population I the diameter of capitulum is semipermanent over a period of 2008-2010 and the variation coefficient is too weak - 6,01-8,91% (fig. 2). But the number of capitulum on the monocarpic *scion*s (shoots) of *C. jacea* is considerable. In 2008 their number was the biggest - 14,1±0,45, by 2010 the capitulums' number began to reduce rapidly. The considerable variation coefficient is 10,51-25,21% (table 1). The similar situation was in the population II: the capitulums' diameter was more or less stable but the variation coefficient was average with 8,56-12,68%. The capitulums' number was gradually reducing from 2008 to 2010.

Maximum of capitulums on the model monocarpic *scion* of *C. jacea* was recorded in the population III in 2008 - 14,7 ± 0,43, the coefficient of variation was considerable and totaled 27,02%. In 2009 the number of capitulums reduced considerably by 7,1 ± 0,19, and in 2010 increased again by 8,6 ± 0,24. The capitulums' diameter was stable (fig. 2; table 1).

The most stable quantitative variables of *C. jacea* generative sphere were recorded in population IV, where the diameter and the capitulums' number didn't almost change over a period of 2008-2010 (fig. 2). The coefficient of variation is weak. It proves the high degree of stable indicators.

Having determined and analyzed the SP variables it can be traced the trend of given population to the process of reproduction over a period of several years. Thus the SP dynamics can be traced in the populations of *C. jacea* at the monitoring areas.

The comparative analysis of SP has been carried out in the four populations of *C. jacea*. The results of SP research of the studied species have been introduced in the table 2. The given results prove that PSP as well as ASP were changing significantly over a period of all studied years (fig. 3).

The minimum value of PSP and ASP were recorded in the population II (table 2).

The maximum index of PSP was recorded in the population III in 2008 (fig. 3). The main indicator, however, that characterizes the SP efficiency in the studied populations best of all is the coefficient of the seed production (CSP) (table 3).

Having analyzed the obtained in all studied populations of *C. jacea* CSP results it can be drawn a conclusion that the best conditions for the growth of the given specimen of this species are in the areas of growth of the population II and population IV. The maximum CSP is 86, 8% in the population II, despite the indices of PSP and ASP are low (fig. 3) and the number of enrichment shoots and capitulums on the model monocarpic scion in the population II is also the lowest (fig. 2, table 1). It proves that almost all seeds which start the formation in the capitulum are not affected and formed into ripe and full-grown. The same trend is in the popu-

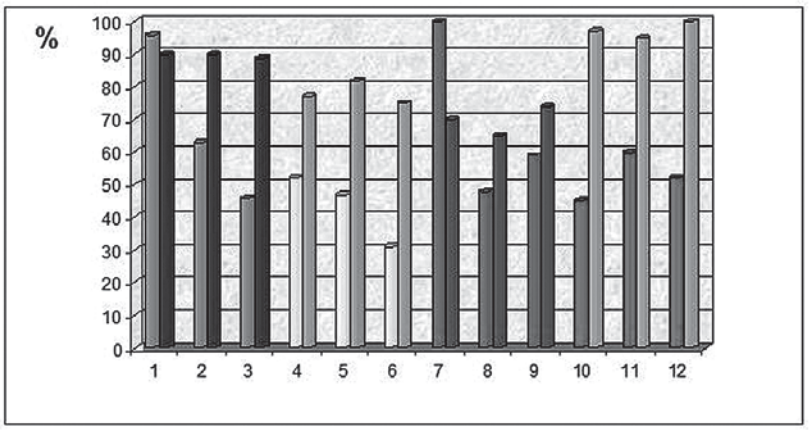

Fig. 2. Diameter and capitulums' number change in populations of *Centaurea jacea* over a period of 2008-2010.
Explanation: - capitulums' number per specimen in %: - capitulums' diameter in %.
X direction – years of research and areas: 1-3 – population I (2008-2010 correspondingly), 4-6 - population II (2008-2010), 7-9 - population III (2008-2010), 10-12 - population IV (2008-2010).

Table 2

Seed productivity in populations of *Centaurea jacea*

№ of population	Years of research	Potential seed productivity (PSP), pcs.			Actual seed productivity (ASP), pcs.			Coefficient of the seed productivity (CSP), %
		M	m	V, %	M	m	V, %	
1	2008	702,2	23,98	17,07	499,1	9,26	9,28	71,08
	2009	482,6	12,61	13,06	332,5	5,39	8,11	68,9
	2010	431,4	12,47	14,45	319,6	7,09	11,09	74,08
2	2008	434,4	11,72	13,49	359,2	4,86	6,76	82,69
	2009	450,3	13,49	14,98	389,6	5,06	6,49	86,52
	2010	309,2	9,82	15,88	281,9	3,58	6,35	91,17
3	2008	943,3	21,84	11,58	710,4	36,90	25,97	75,31
	2009	515,5	9,80	9,51	328,6	14,15	21,54	63,74
	2010	554,4	11,90	10,73	466,0	16,16	17,34	84,05
4	2008	527,8	8,89	8,42	418,7	12,18	14,55	79,33
	2009	646,7	21,74	16,81	571,1	16,89	14,79	88,31
	2010	645,2	15,61	12,10	486,2	14,56	14,97	75,36

Footnote: M - arithmetic mean; m - mean deviation; V – coefficient of variation, %

lation IV. The CSP is 81%. The PSP and ASP are significant and the coefficient of variation is average.

The minimum CSP was recorded in the population I (71,35%) and the population III (74,37%), despite the number of capitulums on the model monocarpic scion in these populations was the biggest and totaled correspondingly 10,1 ± 2,14 and 10 , 13 ± 2,32 (table 3).

As the regeneration of populations with the specimen of various vitality is exceptional by generative reproduction, the ration between ASP and PSP can be interpreted like a potential of stressful reaction of plants' populations.

The data of *C. jacea* CSP considering the conditions of the growth area allow to state about the ability of populations to species self-maintenace and vitality as a whole.

The reduction of SP can be connected with the high density, trampling down and mowing down, intraspecific competition of specimen in the populations as well as with the effect of biotic factors.

The specimen of *C. jacea* in the population I and population II can produce a number of ripe seeds as there are lots of capitulums on the model monocarpic scion. However, it can be observed the abrupt reduction of their SP.

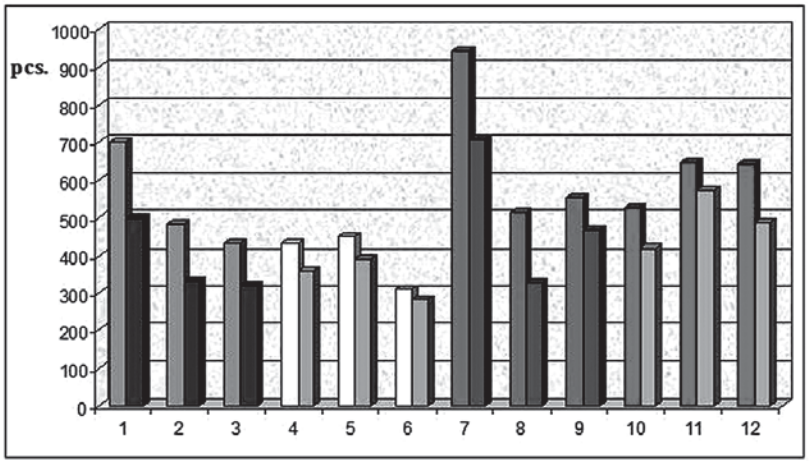

Fig. 3. The quantitative indices of PSP and ASP change in the studied populations of *Centaurea jacea* over a period of 2008-2010.
Explanation: - quantitative indices of PSP, - quantitative indices of ASP. X direction – years of research and areas: 1-3 – population I (2008-2010 correspondingly), 4-6 - population II (2008-2010), 7-9 - population III (2008-2010), 10-12 - population IV (2008-2010).

A number of researchers believe that the meteorological conditions of the specific year tip the balance as a result of which is the seed productivity change year after year especially in the period of budding, flowering and fruit ripening. They think that out of the external factors the weather conditions, coincided with the phenological stages, formation of fruit and seeds always influence the number of seeds.

As a result of carried out researches it has been established that under phenology and climatic factors the population II and population III had the similar indices [4]. The results, however, differ greatly in these populations. Consequently, it can't be considered the meteorological conditions as a factor that influences considerably the species SP.

The negative factor that affects the re-

Table 3

Basic quantitative indices of seed productivity in the populations of Centaurea jacea change

№ of population	Coefficient of the seed productivity (CSP), %	Number of capitulums in the specimen, pcs.
1	71,35 ± 1,5	10,1 ± 2,14
2	86,8 ± 2,45	6,33 ± 0,94
3	74,37 ± 5,88	10,13 ± 2,32
4	81,0 ± 3,83	7,66 ± 0,64

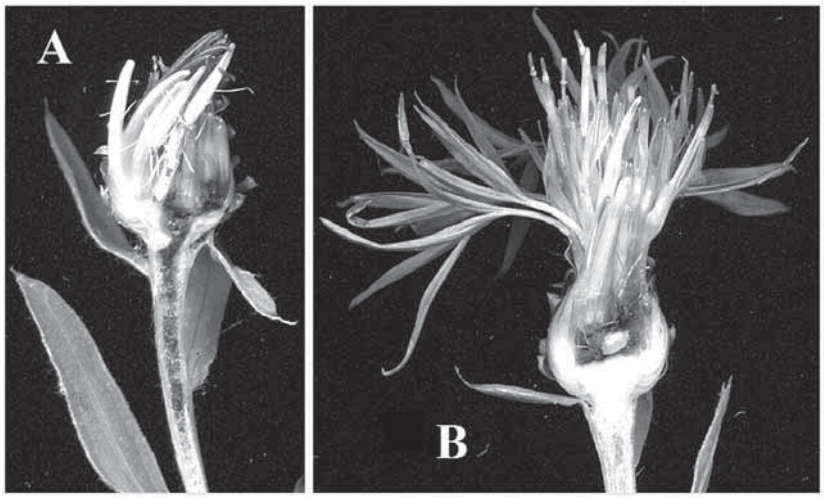

Fig. 4. Capitulums of Centaurea jacea damaged by insect larvae: A - Urophora affinis; B - Terellia virens

duction of seeds number in the capitulum is the anthropogenic factor – mowing down, trampling down (recreation, grazing). The stronger factor is zoogenic – the impact of insects-consorts so called agents of biological control. The agents of biological control are the living organisms which in the process of coevolution established such trophic ties as a result of which bring the considerable damage to the specimen-determinant affecting the number of his population [2, 3].

C. jacea is the eurytopic species with the wide ecological amplitude, able to seize the area displacing the other species. There are, however, the insects – agents of biological control, which controling its number by affecting seed productivity [2, 3]. The adult insects lay the eggs into the capitulum at different stages of their evolution and after the appearance of larva from the egg they start eating the seed buds and tubular flowers. It affects CSP significantly.

To the agents of biological control which mostly influence the reduction of SP in particular CSP refer the next species of insects: two representatives of snout beetles family (*Curculionidae*) - *Larinus minutus*, *L. obtusus*, one species of gelechiid moths family (*Gelechiidae*) - *Metzneria paucipunctella* and four species of fruit fly family (*Tephritidae*) - *Urophora affinis*, *U. quadrifasciata*, *Terellia virens*, *Chaetorellia acrolophi*. The larvas of snout beetles insects damage mostly the capitulums of *C. jacea* especially *Larinus minutus* which were found more in the population I and population III and they were found less in the population II and population IV. Probably it can be explained with the presence of national motor road H 09 not far from the population I and population III. It passes through Lvov, Ivano-Frankovsk and Zakarpattia regions. It starts from Mukachevo, passes through Tiachev, Yablunitsa pass, Ivano-Frankovsk and ends in Lvov. In the outskirts of Ivano-Frankovsk *Larinus minutus* can be seen very often especially on the meadows nearby the lakes (population I) and the rivers: the Bystritsa Solotvinskaia and the Bystritsa Nadvornianskaia where people often rest. Many people stay at the Yablunitsa pass nearby the area of the population III growth (fig. 4).

In the process of research it has been found out one more conformity. In the population I and population II the model monocarpic scion have the considerable range of enrichment with lots of branches. Such an intensified branching we consider like a reaction of the organism to the action of unfavourable conditions of anthropogenic and zoogenic type. It's a fact of common knowledge that the process of mowing intensifies the plants branching but the actions of the biological control agents make the plant to form more generative branches so long as it is raised the possibility that not all the capitulums on the monocarpic scion will be damaged.

Conclusion

Due to the researches it has been established that the *C. jacea* is characterized with the regular seeds formation and distinguished with the different level of seed productivity. It proves the sufficient level of adaptation to the natural-climatic conditions of the growth area. The analysis of the *C. jac*ea seed productivity indices indicates the ecological plasticity of a species. But the generative reproduction of this species has been depressed and observed like an additional aspect in the *C. jacea* self-maintenance of populations.

The researches indicate that the dynamics of SP in different years depends not only on the biological species characteristics, phytocoenotic conditions but also to a great extent on the biogenic factors which are both positive and negative. On the one hand the processes of pollination and blossom dust sprouting as well as fertilization and seminal primordial into the seeds depend on the number of insects-pollinators. On the other hand injurious insects, the agents of the biological control eat seed buds and tubular flowers in the capitulums of *C. jacea* reducing SP.

The basic function of the biocontrol agents is that they are the natural regulator of the abundance of the given species. Being the ruderal species of the poic grass stand, *C. jacea* occupies its environmental niche in it. As a consortium core the *C. jacea* creates the elementary natural ecological system the damage of which will affect the impoverishment of biodiversity.

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