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POPULATION ESTIMATES FOR SOME SPONTANEOUS FRUIT SPECIES IN FOREST ECOSYSTEMS LOCATED IN SOUTHERN ROMANIA

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ABSTRACT

Wild edible fruit species play an important role in maintaining biodiversity, supporting ecosystems and socio-economic valorisation of natural resources. In the temperate zone, hawthorn (Crataegus monogyna), rosehip (Rosa canina) and blackthorn (Prunus spinosa) are notable for their ecological, nutritional, and medicinal value. The present study aimed to estimate the populations of the three species in the Grădinile, Studinița and Vlădila forests (Olt county, Romania), using the T-square method. The results revealed significant variations in population density: R. canina recorded the highest densities in the Studinița Forest (4593.35 individuals/ha), followed by Vlădila (2064.98 individuals/ha), while in Grădinile the number of individuals was insufficient for the application of the method. C. monogyna had the highest density in Studinița (11854.42 individuals/ha), and P. spinosa was present only in the Vladila Forest, where 7274.09 individuals/ha were estimated. These results highlight the high ecological plasticity of hawthorn and the role of the Vladila Forest as a favourable habitat for all three species. The assessment of population numbers provides essential information for the conservation of genetic resources and for the substantiation of measures for sustainable management of forest ecosystems.

INTRODUCTION

Wild edible fruit species represent important resources of natural ecosystems, they not being cultivated or domesticated, but being accessible from various natural ecosystems and exploited by humans since ancient times (Melaku & Ebrahim 2021; Stamin & Cosmulescu 2024a). They play an essential role both in maintaining biodiversity and supporting ecosystems, as well as in improving the socio-economic situation of local communities (Hlangwani et al. 2023, Chisoro et al. 2025). Through their nutritional and therapeutic value, wild fruits contribute to diversifying the human diet and combating food insecurity, a phenomenon that affects hundreds of millions of people globally (Dejene et al. 2020; Jabeen et al. 2024). In temperate zones, wild fruit trees, and shrubs, especially those of the *Rosaceae* family, are of particular importance (Stamin & Cosmulescu, 2024b). Among the most widespread species are hawthorn (*Crataegus monogyna*), rosehip (*Rosa canina*) and blackthorn (*Prunus spinosa*), recognized for their ecological,

nutritional, and medicinal value (Stoenescu et al. 2022; Stamin & Cosmulescu, 2025a). These species provide food and habitat for numerous animal species, contribute to the stability of ecosystems and are important sources of bioactive compounds with therapeutic roles (Kotsou et al. 2023; Marčetić et al. 2022, Stamin & Cosmulescu 2025b). Although they are not considered threatened with extinction, the genetic diversity of these species is subject to anthropogenic pressures and environmental changes (Wawrzyniak et al. 2020). Under these conditions, the assessment of population numbers is necessary to understand their conservation status and to substantiate sustainable management measures for forest resources. The purpose of this research is to estimate the populations of *C. monogyna*, *R. canina*, and *P. spinosa* in three forests located in southern Romania, considering their ecological importance, as well as the therapeutic and economic value that these species can offer.

MATERIALS AND METHODS

Study area

The study was conducted in three forests (Grădinile, Studinița and Vlădila), located in Olt County, Romania. The distances between them are relatively close, with a maximum of 6 km between them. The climatic conditions in the three areas are similar; thus, the climate is temperate continental with low precipitation, especially in summer, and winters are variable. The average annual temperature is between 10.6 °C and 11.5 °C. The relief is flat in all three areas. The dimensions of the three forests are approximately 49 ha for the Grădinile Forest, 66 ha for the Studinița Forest and 407 ha for the Vlădila Forest (Stamin & Cosmulescu 2025).

Data collection

The T-square method (Vincula method) was performed according to Battes, 2018 and was applied for 3 spontaneous fruit species (*C. monogyna*, *R. canina*, *P. spinosa*) in each of the three studied areas, with 30 repetitions for each area and species. It consisted of randomly establishing sampling points and at each point the distance x was measured, which represents the distance from the point to the nearest organism (P) and the distance z, which represents the distance from organism P to its nearest “neighbour” (Q). The condition that must be respected at each measurement is that the angle OPQ (Figure 1) be greater than 90° (90° being the angle of a vincula). Thus, if the nearest “neighbour” does not satisfy this condition, then the next closest one is used. The population density estimate was made according to the formula:

$$\widehat{\mathrm{N}} = \frac{\mathrm{n}^2}{2\sum(\mathrm{x}i)\left[\sqrt{2}\sum(\mathrm{z}i)\right]},$$

where: n = number of observations;
xi = distance from the randomized point to the nearest organism;
z*i* = the distance from the organism to the nearest "neighbour" at an angle >90°;

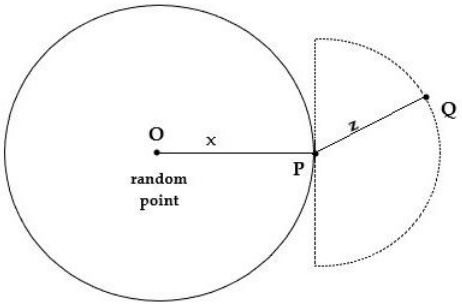

Figure 1. Method of sampling by T-square method (x = distance from the randomized chosen point to the nearest organism, P; z = distance from the P body to its nearest „neighbour", Q)

Finding out the confidence boundaries, by using the formula:

$$\frac{1}{\hat{N}} \pm t * ES\left(\frac{1}{\hat{N}}\right),$$

where: $\frac{1}{\hat{N}}$ = reciprocal of density;

t = value of *t* in the distribution table, to the number of degree of liberty n - 1;

ES = standard error;

Then it was made the transformation of $\frac{1}{\hat{N}}$ into $\hat{N}$ and writing down of confidence range for density estimation.

RESULTS AND DISCUSSIONS

Using the T-square method, the population numbers were estimated in the three areas with different sizes as follows: Vladila>Studinița>Grădinile, for the three fruit species frequently found in the spontaneous flora of Romania, namely: hawthorn (*C. monogyna*), rose hip (*R. canina*) and blackthorn (*P. spinosa*). For the hawthorn species (Table 1), the highest estimated number of individuals was recorded for the Studinița forest of 11854.42 individuals/ha, equivalent to 1.185 individuals/m^2. Despite the large size of the area occupied by the forest in the Vlădila area, the density of this type of fruit tree was much lower, and the average distances between individuals were much greater compared to the other two studied areas, thus X_x was 896 m, and X_z was 0.681 m, determining an estimated number of 5787.14 individuals/ha, equivalent to 0.578 individuals/m^2. Knowing the ecology of the species, often found in thickets, clearings, and forest edges, it can be assumed that the hawthorn prefers light areas (Fichtner & Wissemann 2021). The number of individuals, the age, and the large size of the individuals of the genus *Quercus* present at the site, have determined a dense forest structure that does not favour the spread of individuals of the *C. monogyna* species, which is disadvantaged in this competition (Craine & Dybzinski 2013). The limits of variation recorded were wide for all three areas, the largest interval being identified in the Studinița area, where the difference between the two limits was 2308.21 individuals/ha. In the Vlădila area the identified interval was the smallest, recording a difference in the limits of 885.46 individuals/ha. Silva et al. demonstrated that the T-square method represents a much more realistic population estimation

variant compared to other randomized sampling methods, thus variations in the number of individuals between 267 and 4233 individuals/ha were identified in that study, the difference between the variation limits being 3966 individuals/ha, much greater than those identified by this method in the case of *C. monogyna* in this study.

Table 1

T-square method applied for hawthorn

Grădinile									
ρ in m^2	ρ in ha	X_x	X_z	S^2_x	S^2_z	S_{xz}	SE in m^2	SE in ha	LC
0.712273	7122.72	0.742333	0.668667	0.047267	0.111177	0.012545	0.036345	0.000004	0.000011
			L	N		U			
			6603.39	7122.72		7730.72			
Studinița									
ρ in m^2	ρ in ha	X_x	X_z	S^2_x	S^2_z	S_{xz}	SE in m^2	SE in ha	LC
1.185442	11854.42	0.457667	0.651667	0.031867	0.036221	0.006618	0.026782	0.000003	0.000008
			L	N		U			
			10811.63	11854.42		13119.84			
Vlădila									
ρ in m^2	ρ in ha	X_x	X_z	S^2_x	S^2_z	S_{xz}	SE in m^2	SE in ha	LC
0.578714	5787.14	0.896667	0.681333	0.269294	0.16011	0.086282	0.043262	0.000004	0.000013
			L	N		U			
			5378.08	5787.14		6263.54			
ρ – density; X – average; S2 – variance; S – covariance; SE – Standard Error; LC – Confidentiality Limits; L – lower limit; N – estimated number of individuals; U – upper limit.									

Due to the low number of genotypes of the *Rosa canina* species, in the Grădinile area the T-square method could not be applied to estimate the number of individuals in the population (Table 2), the proposed number of measurements not being achievable. Regarding the population size, it was estimated that the highest number of individuals/ha was in the Studinița Forest area with 4593.35 individuals/ha, equivalent to 0.459 individuals/m^2, and for the Vladila area the estimated number of individuals was almost twice lower compared to the other studied area, registering a number of 2064.98 individuals/ha. This is due to the very large distances between the fruit trees in the Vladila area compared to Studinița. The confidence interval was very small for Vladila, the difference between the limits reaching 291.88 individuals/ha, and in the case of the Studinița area to 1365.14 individuals/ha.

Table 2

T-square method applied for rosehip (*Rosa canina*)

Grădinile									
ρ in m^2	ρ in ha	X_x	X_z	S^2_x	S^2_z	S_{xz}	SE in m^2	SE in ha	LC
-	-	-	-	-	-	-	-	-	-
			L	N		U			
			-	-		-			
Studinița									
ρ in m^2	ρ in ha	X_x	X_z	S^2_x	S^2_z	S_{xz}	SE in m^2	SE in ha	LC
0.459335	4593.352	0.656	1.173333	0.197294	0.99054	0.114855	0.104235	0.000010	0.000032
			L	N		U			
			4010.06	4593.35		5375.20			
Vlădila									
ρ in m^2	ρ in ha	X_x	X_z	S^2_x	S^2_z	S_{xz}	SE in m^2	SE in ha	LC
0.206498	2064.983	0.971333	1.762667	0.092805	1.117262	0.164183	0.1121	0.000011	0.000033
			L	N		U			
			1929.30	2064.98		2221.18			
ρ – density; X – average; S2 – variance; S – covariance; SE – Standard Error; LC – Confidentiality Limits; L – lower limit; N – estimated number of individuals; U – upper limit.									

The rosehip populations in southern Romania are relatively well represented, the species having great ecological plasticity and adaptability to diverse soil and climate conditions (Medveckienė et al. 2023), but despite this, in the Grădinile Forest the number of individuals was very low. From an ecological point of view, rosehip contributes to soil stabilization and has an important role in the formation of the protective shrub layer (Stamin & Cosmulescu 2024).

In the case of *P. spinosa* (Table 3), the absence of this species was noted in the Studinița and Grădinile forests, the species being found in a large number of individuals only in the Vladila Forest. The average distances between fruit trees a were 0.609 for X_x and 0.797667 for X_z, and the estimated number of individuals reached the value of 7274.09 individuals/ha or 0.727 individuals/m^2. The dove tree frequently appears in the edge areas, clearings, and edges of forest roads, being a rustic, resistant species and adapted to poorer soils (Vander Mijnsbrugge et al. 2013). The dove tree populations usually have a more compact distribution in certain areas, such as the Vladila Forest, where they form dense thickets. Through its fruits, the species has high ecological importance, serving as a source of food for animals, especially in late autumn (Pesotskaya et al. 2020).

Table 3

T-square method applied for blackthorn (*Prunus spinosa*)

Grădinile									
ρ in m^2	ρ in ha	X_x	X_z	S^2_x	S^2_z	S_{xz}	SE in m^2	SE in ha	LC
-	-	-	-	-	-	-	-	-	-
			L	N		U			
			-	-		-			
Studinița									
ρ in m^2	ρ in ha	X_x	X_z	S^2_x	S^2_z	S_{xz}	SE in m^2	SE in ha	LC
-	-	-	-	-	-	-	-	-	-
			L	N		U			
			-	-		-			
Vlădila									
ρ in m^2	ρ in ha	X_x	X_z	S^2_x	S^2_z	S_{xz}	SE in m^2	SE in ha	LC
0.727409	7274.089	0.609333	0.797667	0.079158	0.08866	0.022971	0.039052	0.000004	0.000012
			L	N		U			
			6696.21	7274.09		7961.14			

ρ – density; X – average; S2 – variance; S – covariance; SE – Standard Error; LC – Confidentiality Limits; L – lower limit; N – estimated number of individuals; U – upper limit.

The results obtained highlighted the essential role that wild fruit species play in the dynamics and stability of forest ecosystems. The different population distribution for *C. monogyna*, *R. canina* and *P. spinosa* reflects not only the ecological particularities of each species, but also the influence of anthropogenic factors and interspecific competition. In this regard, hawthorn stood out for its high ecological plasticity, being present in all three study areas, while rosehip and pigeonberry showed a more restricted distribution. These results confirm the importance of spontaneous fruit species not only for maintaining biodiversity, but also for providing valuable resources with a nutritional and medicinal role (Sardeshpande & Shackleton 2019; González-Zamorano et al. 2025)

An important aspect is also represented by the need to integrate wild fruit tree and shrub species into sustainable forest management strategies. In areas with low densities, such as the rosehip in the Grădinile Forest, monitoring and protection measures are required against anthropogenic pressures, such as grazing and logging,

which can limit natural regeneration (Caetano et al. 2024). In contrast, in areas with dense and stable populations, such as that of *P. spinosa* in the Vlădila Forest, resources can be exploited in a sustainable way through responsible fruit harvesting and the promotion of traditional value-added products (Suwardi & Navia 2023). At the same time, the use of these species in forest curtains, soil stabilization plantations and reforestation projects can contribute to landscape adaptation to climate change and to strengthening ecosystem resilience (Negi et al. 2025). The involvement of local communities in the conservation and exploitation processes of wild fruits is also crucial. Traditional perceptions and practices can provide useful information for identifying threats and developing management solutions adapted to the local context (Oluoch et al. 2023; Chamorro et al. 2021). In addition, studies on wild relatives of cultivated species show significant potential for genetic improvement and agricultural diversification, with wild fruits being a prime example (Migicovsky et al. 2022). Due to their character, ecological resilience and multiple value, *C. monogyna*, *R. canina* and *P. spinosa* represent important genetic resources for the circular bioeconomy and for the creation of multifunctional landscapes, where ecological benefits are significant. Thus, it is necessary to develop in situ and ex situ conservation programs, corroborated with in-depth genetic and ecological assessments, to ensure the sustainable use of these species in the long term (Negi et al. 2025).

CONCLUSIONS

Following the population estimates that were carried out, it was found that the rosehip recorded the highest densities per hectare in the Studinița and Vladila forests. Thus, the population maximum of this species was reached in the Studinița Forest, followed by the Vladila Forest, the number of individuals in the Grădinile Forest, in the case of *R. canina*, being below the limit established for carrying out the measurements. In the Grădinile Forest, the determinations could only be carried out for the *C. monogyna* species, where the density per hectare was, in terms of value, positioned between the values obtained for the other two forests. And in the case of the *P. spinosa* species, the determinations were only possible for the Vladila Forest, this species being absent in the other two studied areas. Thus, even if denser vegetation can inhibit the density of individuals in the shrub layer, in this case the Vladila Forest represented an optimal habitat for all three species studied, and the hawthorn presented a much higher ecological plasticity than the other two spontaneous fruit species.

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