Research Journal of Agricultural Science, 57 (1), 2025; ISSN: 2668-926X

http://doi.org/10.59463/RJAS.2025.1.06

POPULUS ALBA: A KEY SPECIES IN THE AGROFORESTRY SYSTEM ESTABLISHED IN CÂRCEA, DOLJ COUNTY

Cristian Mihai ENESCU

Department of Soil Sciences, University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăști Boulevard, 1st District, Bucharest, Romania
Corresponding author: mihai.enescu@agro-bucuresti.ro

Abstract. *Agroforestry systems play a vital role in mitigating climate change impacts, especially in vulnerable regions like southeastern Romania, where drought significantly challenges young forest stands. In 2023, twenty 24m x 24m plots were established in HortiNova Nursery, located in Cârcea, near Craiova, Dolj County, combining forest species and agricultural crops. In two of these plots the combination between white poplar (Populus alba L.) and strawberry was introduced. This study aimed to assess the survival rate of the planted white poplar seedlings and their growth in heigh and collar diameter in the first year after planting. Additionally, climatic data (temperature, relative humidity, and precipitation) were collected using six HoBo sensors (Onset Computer Corporation) and one iMETOS 3.3 data logger. Soil analyses were conducted by the Dolj Office of Pedological and Agrochemical Studies. Out of the 144 white poplar seedlings, only 3 failed to survive, resulting in a survival rate of 97.9%. The shortest young tree measured 1.42 m, whereas the tallest one reached 3.34 m. The smallest collar diameter was 0.72 cm, while the largest was 6.12 cm. These findings indicate that the young white poplar trees exhibited strong growth and adaptability, contributing to their success in an environment with poor soil quality and minimal rainfall. In the face of rising temperatures and decreasing rainfall, white poplar remains a viable option for establishing both traditional forestry cultures and innovative agroforestry systems, especially in regions with poor forest land, such as Dolj County.*

Keywords*: agroforestry, diameter, growth, Populus, survival rate, white poplar*

INTRODUCTION

Agroforestry systems are receiving growing global attention due to their various benefits for both landowners and the environment (BUDĂU et al., 2023; ENESCU & CARADAICĂ, 2023; KALA, 2024), protective forest shelterbelts being one of the most common agroforestry systems worldwide and especially in Romania (ENESCU, 2024). These systems have been utilized for a long time, with the traditional concept and knowledge of integrating trees into farming being passed down through generations (PAUDEL & SHRESTHA, 2022).

Various tree species have been incorporated into agroforestry systems, with only a few examples involving poplars. One such example highlights the benefits of combining poplar (*Populus nigra* 62/154 clone) with alfalfa (*Medicago sativa* L.), particularly due to alfalfa's importance as livestock feed. Furthermore, mixed cropping is valued for its ability to increase productivity, provide a primary source of income for farmers, and improve soil fertility, positioning it as a promising strategy for agroforestry (HENAREH et al., 2025).

Black poplar (*Populus nigra* L.) and white poplar (*Populus alba* L.) are among the most widely planted tree species worldwide due to their exceptional adaptability. In Hungary, for instance, poplars (*Populus* sp.) and black locust (*Robinia pseudoacacia* L.) are key species in reforestation and afforestation projects (MULYANA et al., 2024). In Italy, since the early 2000s, numerous forestation initiatives have been undertaken in the floodplains of the Po River to restore abandoned or damaged riverbanks and establish natural populations of black poplar for species conservation and future seed collection (CANTAMESSA et al., 2024). In Ukraine, white poplar stands hold significant ecological and economic value (VYSOTSKA et al., 2021). In

http://doi.org/10.59463/RJAS.2025.1.06

Egypt, poplars have shown promise as woody trees suitable for cultivation on desert soils under arid conditions, with good quality wood production confirmed (HASSAN et al., 2021). Additionally, several afforestation projects in China have focused on loess soils (JIANG et al., 2019) and ecological restoration efforts (WU et al., 2021).

Romania has significant experience in using poplar species for afforestation and ecological restoration of forest ecosystems impacted by various factors, including landslides (CONSTANDACHE et al., 2019). Additionally, poplars have been employed in the afforestation of sandy soils in the southern part of the Oltenia Region (ENESCU, 2019).

White poplar is highly valued for its rapid growth, broad genetic diversity, and ability to produce coppice, making it suitable for various uses (KINDIE & BEKELE, 2024), including the international efforts of carbon sequestration (SOHRABI et al., 2015). Native to riparian steppe and coastal forest ecosystems in central and southern Europe, it spans a wide distribution range, from North Africa to Poland and from the Iberian Peninsula to western Siberia and Central Asia (CAUDULLO & DE RIGO, 2016). In some regions, its wood is effectively used as firewood (GRIU & LUNGULEASA, 2016). White poplar is resilient to both abiotic and biotic stress, making it well-suited for afforestation efforts in response to shifting climatic and environmental conditions (UZAN EKEN et al., 2024) or for afforestation of salty soils (BERITOGNOLO et al., 2007). Its litter positively influenced soil properties related to the nitrogen cycle, even in trace element-contaminated soils, highlighting the importance of litter in forest ecosystems. It was reported that its litter increased the availability of Cd and Zn in acidic soils but had minimal impact on neutral soils (CIADAMIDARO et al., 2014). Additionally, white poplar leaf extracts have therapeutic properties (ABO-ELMAATY et al., 2024). In Romania, recent studies have identified primarily polyphenolic compounds, such as phenolic acids and flavonoids, secondary metabolites known for their antioxidant properties, which are particularly beneficial in combating oxidative stress disorders (GĂLĂȚANU et al., 2025). Its presence in Romania is further emphasized by the names of over 30 localities derived from the Romanian word "plop," meaning poplar in English (SIMON et al., 2018).

The aim of this study was to assess the survival rate and the increment of white poplar seedlings in an agroforestry system established in HortiNova Nursery.

MATERIAL AND METHODS

The experimental plot is in Cârcea, near Craiova (Dolj County; 44°16'53.6"N, 23°55'37.7"E), within the HortiNova nursery, a private company (Figure 1). The total area of 1.15 hectares was divided into 20 square plots with sides of 24 m, each containing a unique combination, as follows: plot no. 1 – tiny forest, with a combination of more than 15 tree and shrub species, plot no. 2 – pedunculate oak (*Quercus robur* L.), red oak (*Q. rubra* L.), Turkey oak (*Q. cerris* L.) and sessile oak [*Q. petraea* (Matt.) Liebl.], plot no. 3 – raspberry (*Rubus idaeus* L.), plot no. 4 – vegetables, plot no. 5 – Turkey oak, plot no. 6 – vegetables, plot no. 7 – white poplar with strawberry (*Fragaria* spp.), plot no. 8 – blackberry (*Rubus fruticosus* L.), plot no. 9 – white poplar with strawberry, plot no. 10 – red oak with Siberian elm (*Ulmus pumila* L.), plot no. 11 – oaks with wild privet (*Ligustrum vulgare* L.), plot no. 12 – red oak, plot no. 13 – sessile oak with field maple (*Acer campestre* L.) and honey locust (*Gleditsia triacanthos* L.), plot no. 14 – red oak and dogwood (*Cornus sanguinea* L.), plot no. 15 – oaks with Sycamore maple (*Acer pseudoplatanus* L.), plot no. 16 – maize (*Zea mays* L.), plot no. 17 – red oak and green ash (*Fraxinus pennsylvanica* Marsh.), plot no. 18 – oaks and mulberry (*Morus alba* L.), plot no. 19 – maize and plot no. 20 –linden (*Tilia cordata* Mill.), rose hip

http://doi.org/10.59463/RJAS.2025.1.06

(*Rosa canina* L.) and oak. So, two plots were dedicated to the combination of white poplar and strawberries. The seedlings were locally grown and planted on November 26, 2023 (Figure 2a).

Figure 1. The 20 experimental plots established in HortiNova Nursery (Source: Google Earth)

Each of the two plots consisted of 6 rows of white poplar, with 24 seedlings per row, spaced 4 meters apart between rows and 1 meter between seedlings within a row. Strawberries were planted between the white poplar rows on the same day, with a spacing of 50 cm between each plant. Additionally, in plot no.7, an irrigation system was installed on July 6, 2024, on row no. 2 and on 4 out 5 rows with strawberries, and a quantity of 36 cubic meters of water was distributed on each row until the end of August 2024 (Figure 2b).

Figure 2. Day of planting (a) and day when the irrigation system was installed (b)

http://doi.org/10.59463/RJAS.2025.1.06

Climatic data was collected using six HoBo sensors and iMETOS 3.3 data logger. HoBo 1 was installed in plot no. 1, HoBo 2 in plot no. 3, HoBo 3 in plot no. 6, HoBo 4 in plot no. 9, HoBo 5 along the irrigation system, located in the proximity of the experimental plots, and HoBo 6 near plot no. 7.

In this survey, temperature (°C) and relative humidity (%) data, recorded every 30 minutes by the HoBo 6 sensor, were compiled from April 1 to September 15, 2024, using Microsoft Office Excel. Each HoBo sensor (model U23-001A Data Logger U23 Pro v2 Temperature/Relative Humidity) was positioned 1.5 meters above the soil surface.

The iMETOS 3.3 data logger was positioned near the experimental plots, 10 meters from plot no. 3.

Soil analyses were carried out in plots no. 2 and 5 by the Dolj Office of Pedological and Agrochemical Studies, measuring pH (soil reaction), humus content (%), total nitrogen (%), as well as phosphorus (P) and potassium (K) levels (ppm).

On March 6, 2025, the height and collar diameter of the seedlings in plot no. 7 were measured. The height (H, m) was recorded using a telescopic measuring rod (Figure 3a), while the collar diameter (D, cm) was measured with a digital caliper (Figure 3b). The mean, minimum, maximum values, standard deviations, and coefficient of variation were calculated using Microsoft Excel.

For half of the seedlings the artificial pruning was performed in order to monitor the potential growth of the young trees in 2025 growing season, in comparison with the trees that were not pruned (Figure 3c).

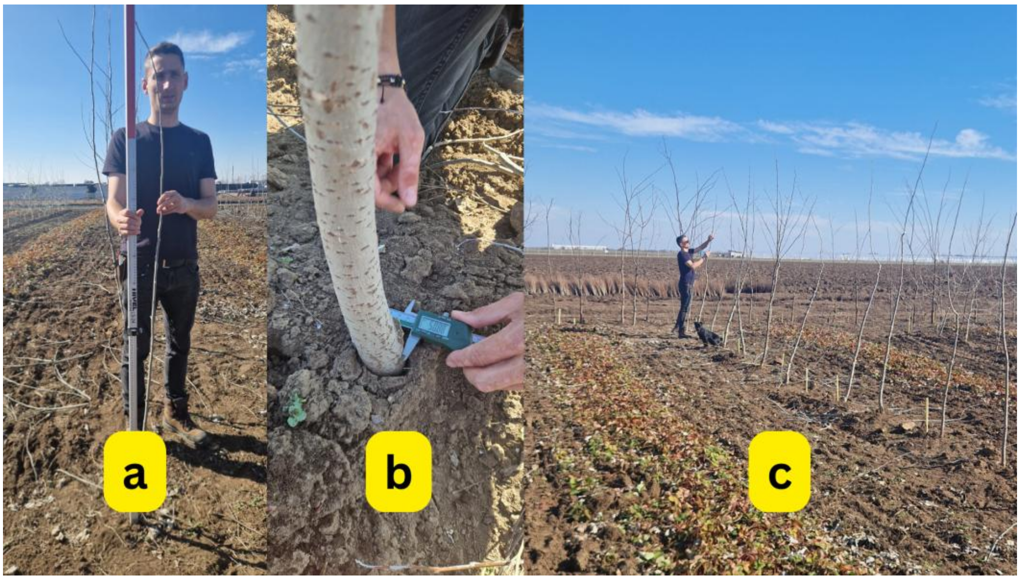

Figure 3. Measuring the height (a), the collar diameter (b) and performing artificial pruning (c)

RESULTS AND DISCUSSIONS

Of the 144 white poplar seedlings, only 3 did not survive (marked with x in Table 1), resulting in a survival rate of 97.9%. Table 1 provides the recorded values for the height (in

http://doi.org/10.59463/RJAS.2025.1.06

cm) and collar diameter (in mm) of each young tree. The shortest young tree measured 1.42 m, whereas the tallest one reached 3.34 m. The smallest collar diameter was 0.72 cm, while the largest was 6.12 cm (Table 1).

Table 1

Height (H) and collar diameter (D) of the 144 planted seedlings

Tree	Row 1		Row 2		Row 3		Row 4		Row 5		Row 6	
	H (m)	D (cm)	H (m)	D (cm)	H (m)	D (cm)	H (m)	D (cm)	H (m)	D (cm)	H (m)	D (cm)
1	2.42	3.82	3.02	6.12	2.20	4.62	2.32	4.53	2.62	3.92	2.32	3.82
2	2.13	3.92	2.12	3.42	2.32	5.02	2.24	3.21	2.03	2.74	2.12	3.22
3	2.54	4.22	2.24	3.54	2.42	3.92	2.05	3.02	1.83	1.63	1.93	3.65
4	2.34	4.64	2.89	4.32	2.34	3.42	2.45	3.31	2.25	3.21	2.05	2.82
5	1.67	0.72	2.53	4.92	2.18	3.52	2.42	4.93	2.32	4.12	1.62	2.43
6	2.08	3.10	2.14	3.22	2.26	3.42	1.92	4.32	2.52	4.24	2.03	2.83
7	2.03	1.62	2.26	3.62	2.30	3.22	2.32	4.36	2.64	4.23	2.05	3.53
8	2.30	2.83	1.62	0.83	2.44	3.74	2.84	3.82	2.55	3.32	2.04	2.34
9	2.42	3.60	2.42	5.52	2.22	3.34	2.73	3.94	x	x	2.11	2.84
10	2.54	4.32	2.35	3.92	1.94	1.82	2.22	3.52	1.92	2.84	1.94	3.03
11	2.52	2.22	2.40	4.70	2.42	4.14	1.72	1.42	1.84	3.15	1.92	2.34
12	2.58	4.62	2.32	2.92	2.44	3.22	2.06	3.62	2.73	2.23	1.94	2.54
13	2.60	4.08	2.74	4.02	2.32	2.92	2.03	3.84	2.43	3.54	1.82	1.93
14	2.69	4.12	2.94	4.04	2.72	4.32	2.23	4.12	2.18	2.85	2.22	3.03
15	2.62	3.84	2.78	5.05	2.52	3.44	2.32	3.63	3.21	5.32	2.32	3.73
16	2.30	4.03	2.42	4.93	x	x	2.84	3.94	3.06	4.57	2.14	4.03
17	1.68	3.08	3.32	4.48	2.54	4.22	2.14	3.45	3.04	3.82	2.12	3.74
18	2.30	2.04	3.34	5.22	3.02	4.12	2.83	3.95	2.42	4.13	2.83	4.13
19	1.94	4.72	x	x	3.20	5.25	2.54	3.57	1.72	3.32	2.13	3.94
20	1.82	2.12	2.74	4.24	3.05	5.02	2.12	2.94	2.30	4.07	2.64	3.75
21	2.20	1.52	2.44	3.52	2.54	3.64	2.52	3.36	2.12	2.63	2.03	3.21
22	2.34	5.22	2.52	3.64	2.62	4.62	2.03	1.93	1.96	2.52	2.04	2.94
23	2.08	3.54	2.46	3.62	2.54	3.27	2.12	2.34	2.14	2.73	1.43	1.42
24	1.94	1.72	1.86	1.70	2.12	1,83	1.42	0.72	1.65	1.53	1.45	1.23
Mean	2.25	3.32	2.52	3.98	2.46	3.83	2.27	3.41	2.33	3.33	2.05	3.02
Min	1.67	0.72	1.62	0.83	1.94	1.82	1.42	0.72	1.65	1.53	1.43	1.23
Max	2.69	5.22	3.34	6.12	3.20	5.25	2.84	4.93	3.21	5.32	2.83	4.13
SD	0.30	1.21	0.42	1.17	0.30	0.80	0.35	0.98	0.43	0.94	0.31	0.80
CV (%)	13.24	36.43	16.62	29.49	12.35	20.92	15.37	28.76	18.53	28.09	15.07	26.38

Research Journal of Agricultural Science, 57 (1), 2025; ISSN: 2668-926X

http://doi.org/10.59463/RJAS.2025.1.06

The maximum mean values for both height and collar diameter were recorded for the seedlings from row no. 2, where the irrigation system was installed. The mean values were 2.25 m in height and 3.98 cm in collar diameter, respectively.

In 2024, the total recorded precipitation amounted to 238.8 mm. Almost half of the total rainfall occurred in the last three months of the year. During the specified period, temperatures ranged from 1.65°C to 39.13°C, with an average of 21.89 ± 7.23°C. As for relative humidity (RH), it fluctuated between 17.95% and 88.53%, with an average of 54.50 ± 17.47%.

Soil analysis results are presented in Table 2.

Table 2

Soil analysis results

Plot	pH	Humus (%)	N (%)	P (ppm)	K (ppm)
2	5.83	3.16	0.16	66	242
5	5.75	2.76	0.14	20.8	246

These results indicate poor soil quality, as the ideal pH range is between 6.0 and 7.5. According to the Romanian Methodology for Soil Studies (FLOREA et al., 1987), the humus content is low, the nitrogen (N) content is moderate, and the phosphorus (P) and potassium (K) contents are moderate to high.

CONCLUSIONS

These findings suggest that the white poplar young trees demonstrated robust growth and adaptability, which contributed to their success in an environment marked by poor soil quality and a very low amount of rainfall.

The growth in both height and collar diameter was greater in the irrigated cases compared to those where no irrigation was applied.

In the current climate, characterized by rising temperatures and decreasing rainfall, white poplar continues to be a viable option for establishing both traditional forestry cultures and innovative agroforestry systems, particularly in areas with poor forest land, such as Dolj County.

Agroforestry focusing on white poplar could be beneficial in the southern part of Oltenia region prone to high soil erosion and desertification, particularly given the effectiveness of its cover management in reducing erosion rates.

ACKNOWLEDGEMENTS

The research was financed by Tomorrow's Forests Foundation (padureademaine.ro). The author is also grateful to Marian Mechenici and Corina Ciaușu (HortiNova Nursery) for their support.

BIBLIOGRAPHY

1.ABO-ELMAATY, A.M.A., SHARAWY, E., YOUNIS, E.M., ABDELWARITH, A.A., IBRAHIM, R.E., AMER, S.A., DAVIES, S.J., KHALIFA, H.A., 2024 – Therapeutic effects of white poplar (*Populus alba*) leave extract on hepatorenal, stress, and antioxidant-immune parameters of *Oreochromis niloticus* challenged with *Aeromonas veronii*. Italian Journal of Animal Science 23(1): 721-733.

2.BERITOGNOLO, I., BRILLI, F., GAUDET, M., KANGASJARVI, J., KUZMINSKY, E., LORETO, F., PAOLUCCI, I., SABATTI, M., SCARASCIA MUGNOZZA, G., VALENTINI, R., 2007 – Comparative transcriptomics to understand variability of salinity tolerance in white poplar. Proceedings of the 51st Italian Society of Agricultural Genetics Annual Congress Riva del Garda, Italy, 23-26 September 2007.

3.BUDĂU, R., APĂFĂIAN, A., CARADAICĂ, M., BRATU, I.A., TIMOFTE, C.S.C., ENESCU, C.M., 2023 – Expert-Based Assessment of the Potential of Agroforestry Systems in Plain Regions across Bihor County, Western Romania. Sustainability 15: 15724.

4.CANTAMESSA, S., CHIARABAGLIO, P.M., 2016 – Improving Carbon Sequestration in Wetlands Using Native Poplar Genotypes for Reforestation Purposes. Forests 15: 1641.

5.CAUDULLO, G., DE RIGO, D., 2016 – *Populus alba* in Europe: distribution, habitat, usage and threats. In: San-Miguel-Ayanz, J., de Rigo, D., Caudullo, G., Houston Durrant, T., Mauri, A. (Eds.), European Atlas of Forest Tree Species. Publ. Off. EU, Luxembourg, pp. e010368+.

6.CIADAMIDARO, L., MADEJON, P., CABRERA, F., MADEJON, E., 2014 – White poplar (*Populus alba* L.) – Litter impact on chemical and biochemical parameters related to nitrogen cycle in contamined soils. Forest Systems 23(1): 72-83.

7.CONSTANDACHE, C., DINCĂ, L., TUDOR, C., ONEȚ, C., 2019 – The ecological reconstruction of forest ecosystems affected by landslides. Natural Resources and Sustainable Development 9(2): 144-159.

8.ENESCU, C.M., 2019 – Sandy soils from Oltenia and Carei Plains: a problem or an opportunity to increase the forest fund in Romania? Scientific Papers. Series Management, Economic Engineering in Agriculture and Rural Development 19(3): 203-206.

9.ENESCU, C.M., CARADAICĂ, M., 2023 – Which woody species are preferred in the composition of Agroforestry systems in sandy soils of Dolj County? Annals of the University of Craiova – Agriculture, Montanology, Cadastre Series 53(2): 78-83.

10.ENESCU, C.M., 2024 – Perspectives on field protective shelterbelts: an essential component for agroforestry system expansion across Romania. Scientific Papers. Series A. Agronomy LXVII(1): 809-814.

11.ELOREA, N., BĂLĂCEANU, V., RĂUȚĂ, C., CANARACHE, A., 1987 – Metodologia elaborării studiilor pedologice. Institutul de Cercetări pentru Pedologie și Agrochimie, București, 255p.

12.GĂLĂȚANU, M.L., PANȚUROIU, M., CIMA, L.M., NECULAI, A.M., PĂNUȘ, E., BLEOTU, C., ENESCU, C.M., MIRCIOIU, I., GAVRILOAIA, R.M., AURICĂ, S.M., RÎMBU, M.C., SANDULOVICI, R.C., 2025 – Polyphenolic Composition, Antioxidant Activity, and Cytotoxic Effect of Male Floral Buds from Three Populus Species Growing in the South of Romania. Molecules 30: 913.

13.GRIU, T., LUNGULEASA, A., 2016 – The use of the white poplar (*Populus alba* L.) biomass as fuel. Journal of Forest Research 27(3): 719-725.

14.HASSAN, A.A., ABOEL-AININ, M.A., MENESI, A.M., HASSAN, H.A., 2021 – Growth Quality and Bioactive Compounds of Poplar Seedlings as Affected by Different Fertilization Treatments. Journal of Plant Production 12(6): 625-634.

15.HENAREH, J., AHMADLOO, F., PATO, M., 2025 – Evaluation of yield and financial advantages of intercropping of poplar (*Populus nigra* 62/154) with alfalfa (*Medicago sativa* L.) at Saatlou poplar research station of Urmia. Forest Research and Development 10(4): 453-477.

16.JIANG, R., GUNINA, A., QU, D., KUZYAKOV, Y., YU, Y., HATANO, R., FRIMPONG, K.A., LI, M., 2019 – Afforestation of loess soils: Old and new organic carbon in aggregates and density fractions. Catena 177: 49-56.

17.KALA, C.P., 2024 – Agroforestry in a changing climate: Challenges, opportunities and solutions. Ecological Frontiers 45: 26-276.

18.KINDIE, B., BEKELE, D., 2024 – Review on Rooting and Shooting Growth Performance of *Populus alba* in Hydroponic Soil Cultures. International Journal of Basic Sciences and Applied Computing 10(5): 1-8.

19.MULYANA, B., POLGAR, A., VITYI, A., 2024 – Modelling of forest carbon dynamics in different forest management scenarios: A case study on poplar and black locust plantations in Hungary. Forestry Studies 80: 77-89.

20.PAUDEL, Y., SHRESTHA, S., 2022 – Agroforestry Practices Prevailing in SAARC Countries: A Review. Indonesian Journal of Social and Environmental Issues 3(1): 10-18.

21.SIMON, A., ARSENE, G., VECHIU, E., ENESCU, C.M., 2018 – Forest trees in Romanian toponymy. Current Trends in Natural Sciences 7(13): 151-156.

22.SOHRABI, H., PARSAPOUR, M.K, SOLTANI, A., IRANMANESH, Y., 2015 – Early differentiation in biomass production and carbon sequestration of white poplar and its two hybrids in Central Iran. Journal of Forestry Research 26(1): 65-69.

23.UZAN EKEN, B., KIRDOK, E., VELIOGLU, E., OZDEN CIFTCI, O., 2024 – Genetic variation in white poplar (*Populus alba* L.) populations as characterized by SSR markers. Turkish Journal of Botany 48: 1-13.

24.VYSOTSKA, N., RUMIANTSEC, M., KOBERTS, O., 2024 – White poplar (*Populus alba* L.) stands in Ukraine: the current state, growth specificities and prospects of using for forest plantations. Folia Oecologica 48(1): 63-72.

25.WU, N., LI, Z., MENG, S., WU, F., 2021 – Soil properties and microbial community in the rhizosphere of *Populus alba* var. *pyramidalis* along a chronosequence. Microbiological Research 250: 126812.