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Evaluation of biometric features and quality of seedlings from an open nursery in Dobieszyn Forest District

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Abstract: *Evaluation of biometric features and quality of seedlings from an open nursery in Dobieszyn Forest District*. The study presents evaluation of the effectiveness of seedling cultivation in an open nursery in Dobieszyn Forest District. The evaluation was based on measurable parameters, such as: above-ground plant parts, root length and width of the seedling's root neck, which were later verified for compliance with the applicable standard PN-R-67025, and of visual assessment of the seedlings. A division into classes was made, in order to establish the percentage share of individual classes in the entire batch of seedlings. The test shows that 79% of two-year-old pine seedlings represent class I, with 19% in class II and only 2% below the standard, i.e. unacceptable as planting material. In the case of three-year-old seedlings of beech, the results pointed to 76% (class I), 16% (class II) and 8% (unsatisfactory) respectively.

Key words: planting material, Scots pine, European beech, quality standards

INTRODUCTION

Together with economic development of Poland, the percentage of areas degraded by industry has grown as well. This factor, when combined with the Programme for the Augmentation of Forest Cover in Poland, significantly increased the demand for planting materials. Augmentation of the coverage of forests, in particular, within highly destroyed areas and former agricultural lands proved desirable. As a result, open and container nurseries boomed, as production of planting material with parameters adjusted to market needs was made a priority [Łukasiewicz 2013]. The quality of seedlings depends on a number of factors, such as the quality of seeds, the sowing method, the protection measures implemented during the growing season [Barzdajn 2006, Stocka 2015] or seedling mycorrization [Aleksandrowicz-Trzcińska 2004, Kowalski 2005, 2006, 2007, Zagrobelna 2009]. When taken out of the soil, the seedlings must be duly stored and transported to the growing site in such a way as to prevent damage that would cause deterioration of their quality [Łęcki 2015]. Among other important factors are: precision of planting, selection of the appropriate framing, pureness of soil [Obidoska and Semenowicz 2009], or the agricultural machines used [Gaworski et al. 2013]. Additionally, with diversified production methods it is possible to obtain seedlings with different adjustability to unfavourable conditions [Kowalkowski 2010].

Each produced seedling should be appropriate both in terms of physiological and morphological features. Only then can successful cultivation, and plant immunity to external factors, be expected. The physiological condition of seedlings is looked after in plant nurseries through the delivery of the required nutrients. Once taken out of the nursery, where optimum soil moisture and nutrient intake is ensured, the planting material is taken to new grounds, where it often suffers a post-planting shock due to extremely harsh conditions. Fields tend to be weed-grown, with infertile soil, while the lands are either waterlogged or very dry. For these reasons, the biometric features of the seedlings are of major importance. A perfect seedling should be moderately grown (not too exuberant), with untwisted roots and with a mycorrhiza. Additionally, a good seedling must have the appropriate proportions between the above-ground and the underground part. It must be free from mechanical damage caused, for instance, by preventive treatments, digging or pest invasions. The terminal bud and the root system must be well developed, with side shoots growing out of the main shoot [Łukaszewicz 2013]. Finally, the seedlings shall not be crooked or have yellowed conifer needles.

The test aimed at evaluating the quality of seedlings of two forest-forming species, i.e. two-year-old Scots pine (*Pinus silvestris* L.) and three-year-old European beech (*Fagus sylvatica* L.) grown in the open nursery in Dobieszyn Forest District, based on measurable biometric features, such as the above-ground plant parts, root length and width of the root neck, and non-measurable characteristics evaluated in visual assessment.

MATERIAL AND METHODS

The tests were carried out within an open nursery in Dobieszyn Forest District, in the village of Ksawerów. The area of the school equalled 9.03 ha, of which the production area occupied 5.09 ha and was divided into 10 quarters (Fig. 1). The nursery mainly produced Scots

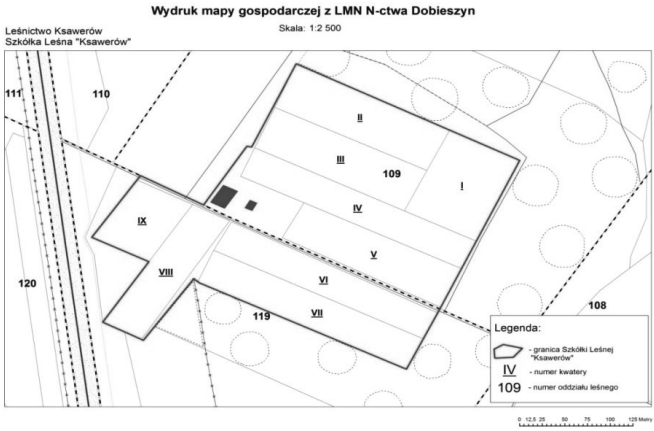

FIGURE 1. Economic map of the nursery in Dobieszyn Forest District

Source: Dobieszyn Forest District.

pine and sessile and durmast common oak, supplemented by European beech, silver birch, black alder, small-leaved linden, European larch, Norway maple, sycamore and mountain-ash.

The two-year old Scots pine seedlings grew in the second quarter, while the three-year-old European beech seedlings were planted in quarter six (Table 1). The total area of quarter two and six equalled 83.4 and 72 ares respectively. Pine occupied 0.3 are, while beech occupied 1.0 are. The area of 1 are was occupied by 14,850 Scots pine seedlings and 8,180 European beech seedlings.

The parameters of two-year-old Scots pine seedlings and three-year-old European beech seedlings were measured in mid-December 2016 within the nursery. Hundred random seedlings of two species were spaded out and taken to a closed room, where selected biometric features were measured. The seedling stand measurements covered: the above-ground part (*h*), length of the root system (*hk*) and root neck diameter (*d*). Seedling slenderness was also assessed in the experiment.

The length measurements were carried out with a tape measure, with accuracy to 1 mm, while diameters were measured with an electronic slide calliper (accuracy: 0.02 mm). The seedlings were also subjected to visual assessment of the terminal bud, the tree stem, the root system and general health of the plant (traces of preying insects).

The results of size measurements were then compared to standard PN-R-67025. The standard did not contain minimum dimensions for root neck of a three-year-old European beech.

TABLE 1. Data concerning the origin and number of Scots pine and European beech seedlings

Data	Scots pine	European beech
Quarter	2	6
Area [are]	0.3	1.0
Number of seedlings [thou. pcs·are^{-1}]	14.85	8.18
Number of certificate of origin	MR/33245/12/P	MR/39726/13/PL
Type of the basic forest material from which the forest reproductive material was obtained	forest stand	forest stand
Name of forest reproductive material's producer	Dobieszyn Forest District	Łagów Forest District
Number in the national register	MP/1/15405/05	MP/1/49790/11
Origin of the basic forest material	native	native
Age and type	two-year-old seedling, not from nursery (2/0)	three-year-old seedling, not from nursery (3/0)
Cone collection site	Ksawerów 16-02-2-06-90	–
Cone husking plant	Kluczbork – Lasowice Małe	–
Seedling	partial, with the use of seeder	partial, 5 rows, manual

All statistical analyses were performed using Statistica 12 software. Before the analyses, normal distribution was verified using the Shapiro–Wilk's W test. Linear correlation was also analysed, to define the impact of the features evaluated (height of the above-ground part, root neck thickness and root length). The relation strength was assessed based on materiality of the linear correlation coefficient with $\alpha = 0.05$.

RESULTS AND DISCUSSION

In order to achieve the pre-determined quantity and quality of production of the planting material, the nursery conducted a number of preventive, forecasting, diagnostic and risk-eliminating actions.

With all this, the nursery grew pine and beech seedlings with the size parameters specified in Table 2.

Tests on two-year-old Scots pine seedling showed that the average height of the over-ground part of the plants equalled 200 m, the root length was by 26% bigger and equalled on average 227 mm and the root neck diameter equalled 3.87 mm (Fig. 2). Comparison of the measurements of the above-ground part of the plant with those obtained by Zajączkowski and Krajewski [2002] showed that on average, the results obtained herein for this biometric feature were higher. The tests performed by the above-mentioned authors, carried out in Skierniewice Forest District in 2000 on two-year-old pine seedlings, showed the average size of 200 mm (from 180 to 240 mm). As the authors proved, the height of the above-ground part of seedlings is connected with the fertilisation. The two-year-old Scots pine (2/0) seedlings collected for measurements reached the biggest sizes on plots fertilised with peat when vaccinated with my corrhizal inoculum, and in the mixture of manure plus soil from under broadleaved trees. The smallest sizes, in turn, were reported for seedlings from lands fertilised using manure and inoculated, i.e. in a mixture of peat and pine bark or in pine bark only.

TABLE 2. Statistical parameters of the measured parts of Scots pine and European beech seedlings

Species	Parameter	*AVG*	Min	Max	Range	*SD*	*CV*	*SE*
		mm					%	mm
Scots pine	height of the over-ground part, *h*	220	140	310	170	44	20	4
	length of the root system, *hk*	277	200	370	170	37	13	4
	root neck diameter, *d*	3.87	1.89	7.15	5.26	1.13	29.12	0.11
	slenderness	1 : 6	1 : 3	1 : 10	–	–	–	–
European beech	height of the over-ground part, *h*	571	390	850	460	99	17	10
	length of the root system, *hk*	266	160	370	210	31	12	3
	root neck diameter, *d*	6.63	3.71	12.80	9.09	2.01	30.38	0.20
	slenderness	1 : 9	1 : 6	1 : 12	–	–	–	–

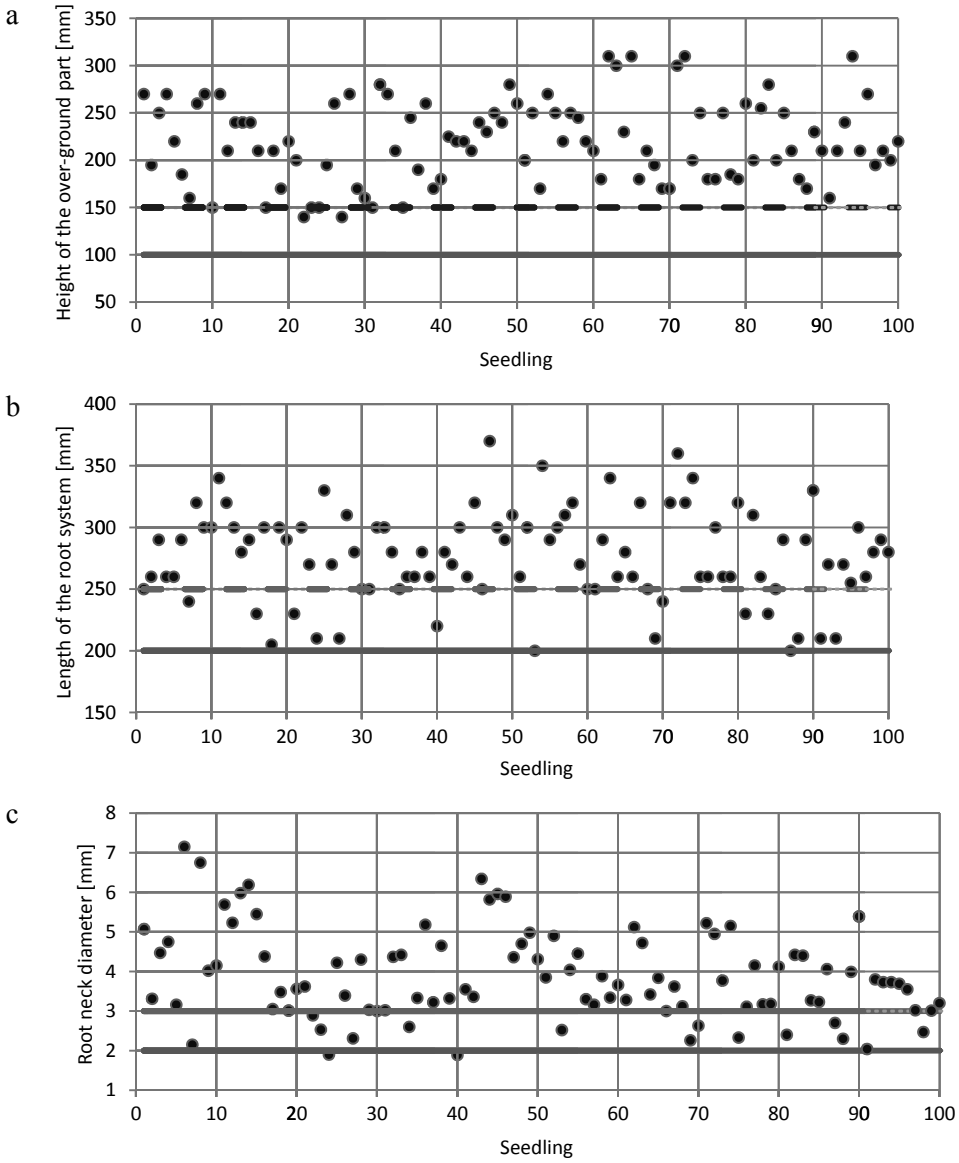

FIGURE 2. Distribution of parameters of the pine seedlings measured, with reference to threshold values: a – height of the over-ground part, b – length of the root system, c – root neck diameter

When it comes to the root neck, the seedlings tested had a much lower diameter than those described by Zajączkowski and Krajewski [2002]. In the a for equoted tests, the average root neck diameterequalled5 mm. The root length, in turn, was similar for both tests and equalled, on average, 265 mm.

Similar tests were conducted in the Czarna Białostocka Forest District

in 2001 [Zajączkowski and Krajewski 2002]. The seedlings covered by this analysis had a much lower over-ground part (160 mm on average). The longest shoots were developed by seedlings from plot fertilised with a combination of peat and soil from under coniferous trees, while the shortest ones were developed where manure, bark of broadleaved trees or pine bark was used.

The root length obtained in the tests carried out by the above-mentioned authors was comparable to the results presented herein, while the root neck diameter was comparable to the results obtained in Skierniewice Forest District, i.e. higher by ca. 30% than the values presented in this study.

The diagrams (Fig. 3) show the distribution of individual parameters obtained in the tests of the Scots pine. The values categorised as class I are located on or above the dotted line. The values between the dotted line and the solid line represent class II, while those below the solid horizontal line do not meet the minimum standards set forth by PN-R-67025.

Measurements of three-year-old European beech seedlings showed that the plants were on average 571 mm high (the above-ground part). The length of their roots equalled 266 mm and the root neck diameter amounted to 6.63 mm. The authors of the study did not find in the literature available any articles on the biometric features of three-year-old European beech that could be used for comparison.

Another valuable factor indicative of the quality of the seedlings is their slenderness. Seedlings characterised by low slenderness are more resistant to wind and draught and grow faster, wherefore they accommodate easier to dry environment [Johnson and Cline 1991]. The average slenderness equalled 1 : 6 for two-year-old Scots pine seedlings and 1 : 9 for three-year-old European beech. Based on the test of 10-month-old beech seedlings, performed by Wrzesiński [2015] in a container nursery, it was established that the density of seedlings in the container has significant impact on the shoot height-to-thickness ratio. Seedlings planted at lower density were characterised by lower slenderness (1 : 6), which may suggest that the have higher breeding value.

Figure 3a shows the dependency between the root length and the height of the over-ground part for Scots pine and European beech seedlings. The dependency for 100 pine seedlings is significant (R = 0.5166). The test showed that the higher the over-ground part of the plant, the longer the root. Seedling growth by 1 cm cause growth of the root by 0.44 cm. The dependency was not noted for beech (R = 0.2459).

Figure 3b shows a dependency between the root neck diameter and the height of the above-ground part of the seedling. The dependency is significant for both species: the growth of height of the over-ground part seedlings of pine and beech by 10 cm caused growth of the root neck diameter by 0.15 cm (R = 0.5747 and R = 0.7562).

The dependency between the root neck diameter and root length is significant only for pine seedlings (Fig. 3c). Root length growth by 10 cm causes growth of root neck diameter by 0.16 cm (R = 0.5479).

Statistical analyses confirmed the dependency between the root neck

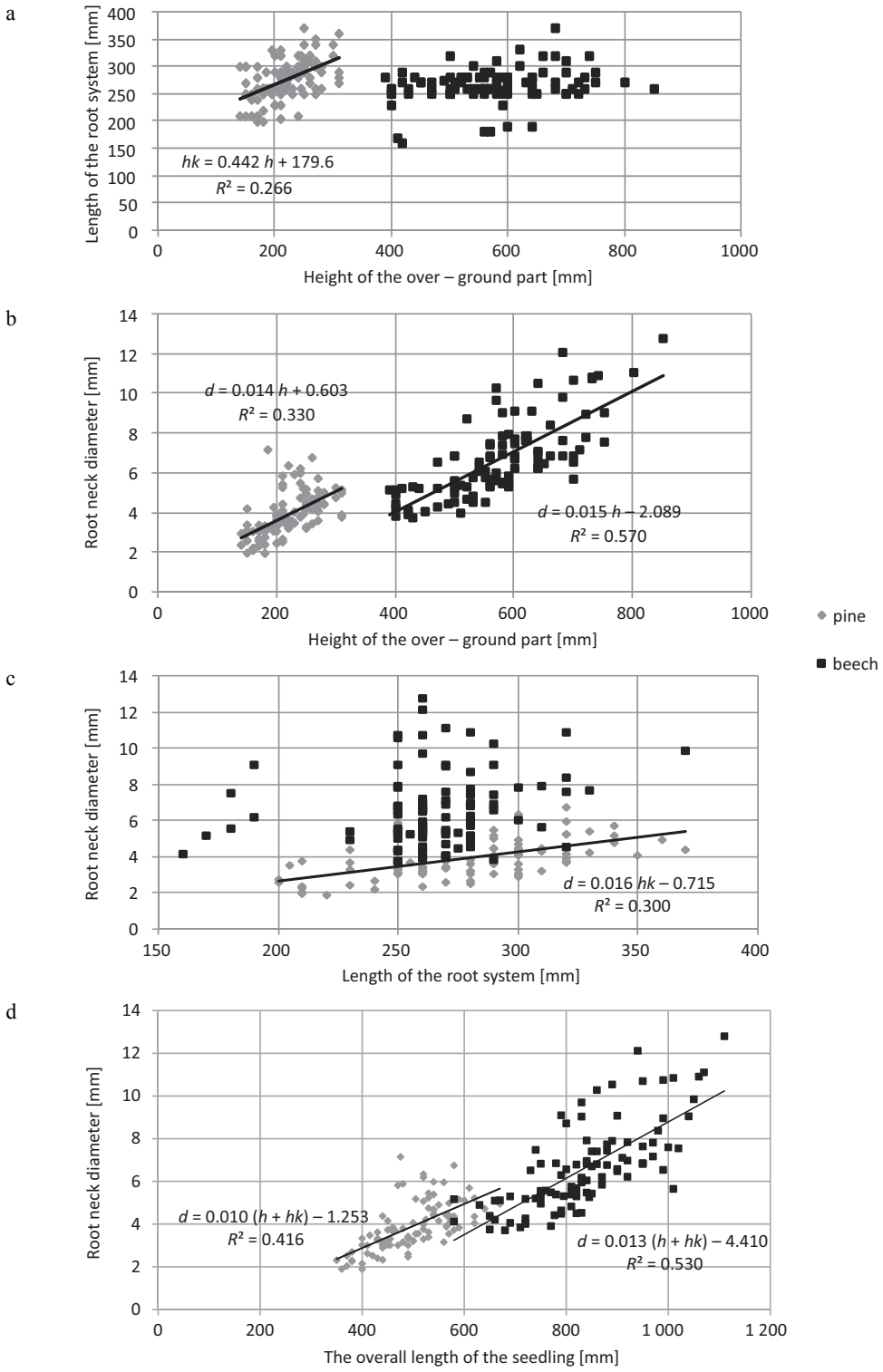

FIGURE 3. Dependencies between the measured parameters of Scots pine and European beech seedlings: a – root length (*hk*) to the height of the over-ground part (*h*), b – root neck diameter (*d*) to the height of the over-ground part (*h*), c – root neck diameter (*d*) to the length of the root (*hk*), d – root neck diameter (*d*) to the overall length of the seedling (*h* + *hk*)

diameter and the overall length of the seedling (Fig. 3d). Growth of the seedling length by 10 cm causes growth of the root neck diameter by 0.10 cm (R = 0.6450) for the pine and 0.13 cm (R = 0.7280) for the beech.

The analysis performed shows that 79 Scots pine and 76 European beech seedlings represented class I, while class II encompassed 19 pine and 16 beech seedlings (Fig. 4). An attempt was made to establish the reasons why the seedlings qualified into quality class II. For the Scots pine, four seedlings had an inadequately long root and another four had a too small root neck diameter to qualify into class I. Nine seedlings were characterised by both (too short root and too small root neck diameter), in one case the above-ground part was too low and one seedling had a too small root neck diameter.

When it comes to beech seedlings qualified into class II, their above-ground part was too low.

Two out of 100 pine seedlings and eight out of 100 beech seedlings did not qualify to any of the classes. The reason behind the rejection of pines was insufficient root neck diameter, while the beech had a root that was too short.

Visual assessment of the seedlings shows that terminal buds of all the plants were healthy and well developed. The trunks were straight and lignified along the entire length. The seedlings had a properly developed root system with numerous side roots. In the case of beech, the main root was very distinctive, which is a sign of proper development. No visible symptoms of excess dryness, mechanical defects or damage caused by frosts (test carried out at the beginning of December). No traces of preying insects, which would decrease the value of the planting material.

CONCLUSIONS

The tests show that 79% of two-year-old pine seedlings qualify into class I, with the remaining 19% included in class II and 2% unclassified and, therefore (i.e. unacceptable as planting material). For the three-year-old European beech, in turn, 76% of the seedlings qualify into class I, 16% into class II and 8% do not meet the requirements.

The seedlings tested satisfy general and, in the majority of cases, also detailed standards, which proves that the planting material is of high quality.

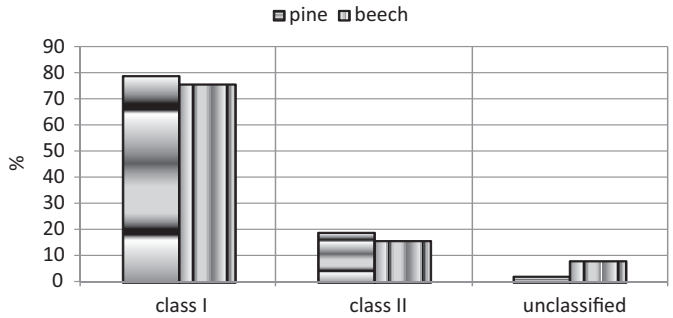

FIGURE 4. Percentage share of class I, class II and unclassified pine and beech seedlings

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Streszczenie: *Analiza cech biometrycznych i jakości sadzonek pochodzących ze szkółki otwartej w Nadleśnictwie Dobieszyn.* W artykule zamieszczono analizy dotyczące poziomu hodowli sadzonek w szkółce otwartej w Nadleśnictwie Dobieszyn. Pod uwagę brano parametry mierzalne (wysokość części nadziemnej, długość korzeni i szerokość szyi korzeniowej), które następnie porównano z obowiązującą normą PN-R-67025, jak również oceniono sadzonki wizualnie. Zmierzone sadzonki poddano podziałowi na klasy jakości w celu określenia procentowego udziału poszczególnych klas w całości. Z badań wynika, że 79% sadzonek dwuletniej sosny mieści się w klasie I, 19% w klasie II, a tylko 2% nie mieści się w normie i nie może być zaakceptowane jako materiał sadzeniowy. W przypadku sadzonek trzyletniego buka aż 76% mieści się w klasie I, 16% w klasie II, a 8% nie mieści się w normie.

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