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**AGE STRUCTURE OF EUROPEAN ASH (*FRAXINUS EXCELSIOR* L.) FORESTS  
IN THE LEFT-BANK FOREST-STEPPE OF UKRAINE**

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The age structure of European ash stands in the forest fund of ten forest enterprises from Sumy, Kharkiv and Poltava regions was analyzed considering forest site conditions, stand origin, site index and ash proportion in the forest composition. The average age of ash stands is 68 years for the Left-Bank Forest-Steppe. On average from 46.1 % to 81.6% of European ash stands survive up to the V age class. The average age of ash stands is the highest in the forest-steppe part of Sumy Region in D<sub>2</sub> and D<sub>3</sub>, in Kharkiv Region in D<sub>1</sub>, and in Poltava Region in C<sub>2</sub> and C<sub>3</sub>. The average age is the highest (75 years) in artificial seed stands in Kharkiv Region, in natural seed (86 years) and vegetative (77 years) origin in Sumy Region. The survival of pure and almost pure ash stands is the highest in Kharkiv Region and the lowest in Poltava Region. In the legislatively adopted maturity age (VIII age class) survival of European ash with its proportion of 80–100 % is 26.5 %, 13.1 % and 3.2 % in Kharkiv, Sumy and Poltava Regions respectively. Correction of the main felling age in forests that are possible for exploitation is suggested considering the possible loss of timber quality as a result of forest damage by different causes.

**Key words:** European ash (*Fraxinus excelsior* L.), forest site conditions, stand origin, site index, ash proportion.

**Introduction.** Recently health condition of forest trees have been worsening (Matsiakh & Kramarets 2014, Davydenko & Meshkova 2017, Linnakoski et al. 2019), which is connected with anthropogenic disturbances (Paap et al. 2018), climate change (Shvidenko et al. 2017), and a spread of injurious organisms (Davydenko & Meshkova 2017). European ash (*Fraxinus excelsior* L.) is currently threatened across most of its distributional range by ash dieback, caused by *Hymenoscyphus fraxineus* (Baral et al. 2014). In eastern Ukraine, first ash decline symptoms were observed in 2010 and the *H. fraxineus* was detected in symptomatic shoots in 2012 (Davydenko et al. 2013). In western Ukraine, *Hymenoscyphus fraxineus* was identified in 2014 (Matsiakh & Kramarets 2014). In addition to ash dieback, ash is affected by tuberculosis (Janse 1982, Kulbanska 2015, Davydenko et al. 2019, Meshkova et al. 2019), root rots (Langer 2017), and also damaged by insects (Meshkova et al. 2017). It results in the premature death of trees and stands, and deterioration of wood quality (Metzler et al. 2012, Langer 2017). Our previous research showed that susceptibility of European ash to different pathogens as well as the severity of tree damage increase with tree age (Meshkova & Borisova 2017). In such a case, the maturity age evaluated by growth dynamics is much higher than the actual age of tree mortality from disease. A similar situation was shown for silver birch (*Betula pendula* Roth) (Meshkova & Koshelyaeva 2019).

*The aim of this work* was to define the age structure of European ash stands in the Left-Bank Forest-Steppe considering forest site conditions, stand origin, site index and ash proportion in the forest composition.

**Materials and Methods.** The “Ukrderzhlisproekt” Production Association Database (by 1.01.2011) was analyzed for the State Forest Enterprises which are located in the Left-Bank Forest-Steppe. Sumy Region was represented by two State Enterprises: “Okhtyrskye Forest Economy” (FE) and “Trostyanetske FE”. Poltava Region was represented by three State Enterprises: “Gadyatske FE”, “Myrgorodske FE” and “Poltavske FE”. Kharkiv Region was represented by five State Enterprises, namely “Vovchanske FE”, “Gutyanske FE”, “Zmiyivske FE”, “Chuguevo-Babchanske FE”, and Kharkivska Forest Research Station of Ukrainian Research Institute of Forestry and Forest Melioration named after G. M. Vysotsky (“Kharkivska FRS”). The territory covers the latitude from 49°35’ N (Poltavske FE) to 50°28’ N (Trostyanetske FE), and longitude from 33°36’ E (Myrgorodske FE) to 36°56’ E (Vovchanske FE) (Table 1). The data for subcompartments with European ash as the main forest-forming species have been analyzed by 10-year age classes for

different forest site conditions, origin (natural and artificial seed origin, vegetative origin), site index, and proportion of European ash in the stand composition.

*Table 1*

**Characteristics of European ash stands in the forest fund of analyzed forest enterprises**

State Forest Enterprise (FE)	Latitude, N*	Longitude, E	Area of ash stands, hectares	Proportion of ash stands, %**	Average age (age class limits in brackets)
Okhtyrskе FE	50°18'	34°54'	1874.9	7.9	69 (II–XV)
Trostryanetske FE	50°28'	34°28'	885.3	4.3	86 (I–XVIII)
Vovchanske FE	50°17'	36°56'	651.0	2.5	67 (I–XIII)
Gutyanske FE	50°08'	35°21'	180.4	0.7	63 (III–XI)
Zmiyivske FE	49°42'	36°22'	410.0	1.1	63 (I–IX)
Chuguevo-Babchanske FE	49°52'	36°44'	875.3	4.4	65 (III–XI)
Kharkivska FRS	50°09'	36°31'	53.2	0.3	65 (III–IX)
Gadyatske FE	50°22'	33°59'	218.8	0.8	59 (III–X)
Poltavske FE	49°35'	34°32'	390.7	1.6	55 (I–XI)
Myrgorodske FE	49°57'	33°36'	643.2	2.6	64 (I–XI)
Kharkiv Region ***	–	–	2169.9	1.7	64 (I–XIII)
Sumy Region ***	–	–	2760.2	6.3	74 (I–XVIII)
Poltava Region ***	–	–	1252.7	1.6	60 (I–XI)
Left-Bank Forest-Steppe ***	–	–	6182.8	2.5	68 (I–XVIII)

\*Latitude and longitude for each forest enterprise were evaluated as centroids of respective contours of the territory using MapInfo Mapping Package.

\*\*Proportion of ash stands from area of forest covered lands, %.

\*\*\*Average for analyzed Forest Enterprises from each region or pooled data for Left-Bank Forest-Steppe.

The probability of stand survival up to the mentioned age class was modeled by the method of Yu. P. Demakov (Demakov 2000), which was successfully tested in the analysis of the survival of pine stands in Sumy Region (Tovstukha 2012), English oak (*Quercus robur* L.) (Meshkova & Didenko 2017) and silver birch (Meshkova & Kosheliaeva 2019) in the Left-Bank Forest-Steppe of Ukraine. According to the method, the proportion of the stand area of each 10-year age class was evaluated for each set of subcompartments with respective forest origin, site condition, site index, and proportion of European ash in the stand composition. Then the proportion of stands' area, which survives up to a certain age, was evaluated.

The data were analyzed using MS Excel. Coordinates for each forest enterprise were evaluated as centroids of respective contours of the territory using MapInfo Mapping Package.

**Results and Discussion.** Area of European ash stands is the largest in analyzed forest enterprises of Sumy Region (average area for FE  $2760.2 / 2 = 1380.1$  ha). Even in Trostryanetske FE with the lowest area of ash stands in Sumy Region this parameter was larger than in all forest enterprises of Poltava Region. In Kharkiv Region, an average area of European ash stands is almost the same as in Poltava Region ( $2169.9 / 5 = 434.0$  ha and  $1252.7 / 3 = 417.6$  ha respectively), but in the northern part of the region (Chuguevo-Babchanske FE and Vovchanske FE) it is close to the value in Trostryanetske FE (see Table 1). The proportion of ash stands is on average 2.4 % for all analyzed Forest Enterprises in the Left-Bank Forest-Steppe. It is the largest (6.3%) for Sumy Region and the same (1.6 %) for Poltava and Kharkiv Regions. The proportion of ash stands highly correlates with ash stands area in the forest fund of forest enterprises ( $r = 0.98$ ;  $r_{0.01} = 0.76$ ). It is the lowest in Gutyanske FE (0.7 %) and the highest in Okhtyrskе FE (2.2 %).

The age class of ash stands varies from I to XVIII in different forest enterprises of the Left-Bank Forest-Steppe. The oldest stands of European ash are in the XVIII age class only in Trostryanetske FE, in XV and XIII age classes – in Okhtyrskе FE and Vovchanske FE respectively, in XI age class – in five forest enterprises, in the X age class – in Gadyatske FE, and in the IX age class – in Kharkivska FRS and Zmiyivske FE (see Table 1). The average age of ash stands is 68 years for the Left-Bank Forest-Steppe. It is the largest in Sumy Region (74 years), the lowest in Poltava Region (60 years) and is 64 years for Kharkiv Region.

The average age of ash stands is the highest in Trostyanetske FE (86 years) and it gradually decreases in the sequence: Okhtyrskе FE (69 years), Vovchanske FE (67 years), Kharkivska FRS (65 years) and so on with the lowest values in Gadyatske FE (59 years) and Poltavskе FE (55 years) (see Table 1). In the dataset of analyzed forest enterprises, the average age class of ash stands tends to increase with latitude but the correlation is insignificant ( $r = 0.55$ ;  $r_{0.05} = 0.63$ ).

Analysis of European ash stands by subcompartments with all origins, forest site conditions, site index and ash proportion in the stand indicates that from 46.1 % (Poltavskе FE) to 81.6 % (Kharkivska FRS) of them survive in the V age class (Table 2).

*Table 2*

**Survival of European ash stands in the forest fund of certain forest enterprises of the Left-Bank Forest-Steppe (all origins, site index and forest site conditions)**

State Forest Enterprise (FE)	Average age	Survival up to age class, %					
		V	VI	VII	VIII	IX	X
Vovchanske FE	67	55.6	49.0	34.6	19.7	19.6	13.4
Kharkivska FRS	65	81.6	58.3	25.0	6.0	0.0	0.0
Gutyanske FE	63	62.8	35.7	24.9	10.9	10.1	1.2
Chuguevo-Babchanske FE	62	59.9	26.9	20.1	12.8	11.6	1.4
Zmiyivske FE	63	60.8	49.8	34.5	29.2	0.0	0.0
Trostyanetske FE	86	75.0	64.5	58.5	40.2	35.8	26.1
Okhtyrskе FE	69	60.9	53.5	40.0	32.9	23.7	12.1
Gadyatske FE	59	66.1	34.1	14.0	0.7	0.7	0.0
Poltavskе FE	55	46.1	38.4	24.5	12.1	7.4	0.7
Myrgorodske FE	64	68.7	51.0	35.8	19.1	8.2	1.4

The part of the stands preserved in the VI age class is from 26.9 % in Chuguevo-Babchanske FE to 64.5 % in Trostyanetske FE. Up to VIII age class which is suggested as the age of maturity, 0.7 and 6.0 % of European ash stands survive in Gadyatske FE and Kharkivska FRS respectively. The highest ash survival in the VIII age class is in Trostyanetske FE and Okhtyrskе FE (40.2 % and 32.9 % respectively). Ash stands in Kharkivska FRS and Zmiyivske FE do not survive up to IX age class, in Gadyatske FE survival is only 0.7 %, and the highest survival in Trostyanetske FE (35.8 %), Okhtyrskе FE (23.7 %) and Vovchanske FE (19.6%) is not so high (see Table 2).

Data grouping by forest site conditions shows that the predominant part of European ash stands grows in D<sub>2</sub> – fresh fertile forest site conditions (fsc) (Table 3).

*Table 3*

**Distribution of area of European ash stands by forest site condition types in the forest fund of certain forest enterprises of the Left-Bank Forest-Steppe (all origins and site index classes)**

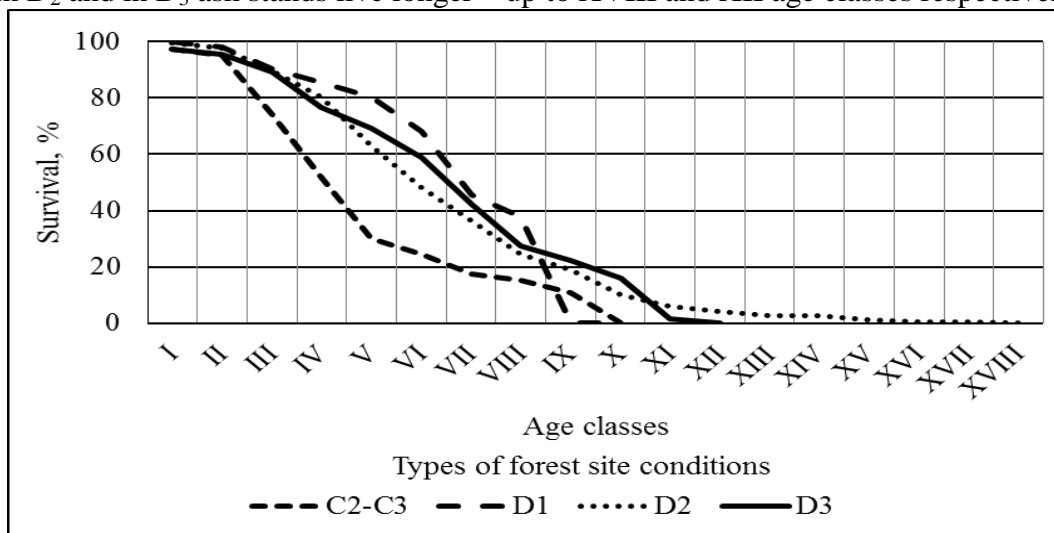
State Forest Enterprise (FE)	Distribution of area, %					
	B <sub>2</sub>	C <sub>1</sub>	C <sub>2</sub> -C <sub>3</sub>	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>
Vovchanske FE	0.00	0.17	0.52	6.79	88.96	3.56
Kharkivska FRS	0.00	0.00	3.95	3.20	85.90	6.95
Gutyanske FE	0.00	0.00	2.51	1.80	91.38	4.31
Chuguevo-Babchanske FE	0.00	0.43	3.49	9.79	85.49	0.79
Zmiyivske FE	0.02	0.39	3.52	41.26	52.13	2.68
Trostyanetske FE	0.17	0.00	0.69	0.75	98.34	0.06
Okhtyrskе FE	0.00	0.00	0.20	0.30	94.41	5.08
Gadyatske FE	0.00	0.00	4.39	0.00	82.22	13.39
Poltavskе FE	0.00	1.43	46.15	0.51	39.98	11.93
Myrgorodske FE	1.41	0.00	4.10	1.51	87.48	5.49
Kharkiv Region *	0.01	0.30	2.53	13.95	80.79	2.42
Sumy Region *	0.05	0.00	0.36	0.45	95.67	3.47
Poltava Region *	0.73	0.45	17.27	0.93	71.75	8.88
Left-Bank Forest-Steppe *	0.17	0.20	4.55	5.29	85.60	4.20

\*Average for analyzed Forest Enterprises from each region or pooled data for Left-Bank Forest-Steppe.

Such proportion is 85.6% in the pooled dataset, from 71.75 % in Poltava Region to 95.67 % in Sumy Region. In Kharkiv Region the noticeable part of ash stands is in D<sub>1</sub> – dry fertile fsc

(13.95 %), and in Poltava Region – in C<sub>2</sub>–C<sub>3</sub> – fresh and moist relatively fertile fsc (46.15 %) and in D<sub>3</sub> – moist fertile fsc (8.88 %). In B<sub>2</sub> (fresh relatively poor fsc) and C<sub>1</sub> (dry relatively fertile fsc) ash stands occupy less than 1 % except for 1.41 % in B<sub>2</sub> in Myrgorodske FE and 1.43 % in C<sub>1</sub> in Poltavske FE (see Table 3).

Survival of European ash in almost all age classes is the lowest in the fresh and moist relatively fertile forest site conditions (Fig. 1). In the fertile site conditions, ash survival decreases gradually. In the interval between III and VIII age classes the survival is the highest in D<sub>1</sub> and the lowest in D<sub>2</sub>, but in D<sub>2</sub> and in D<sub>3</sub> ash stands live longer – up to XVIII and XII age classes respectively.



**Fig. 1 – Survival of European ash stands in the particular forest site conditions in the forest fund of analyzed forest enterprises of the Left-Bank Forest-Steppe (all origins and site index classes) (C<sub>2</sub> – fresh relatively fertile forest site conditions (fsc); C<sub>3</sub> – moist relatively fertile fsc; D<sub>1</sub> – dry fertile fsc; D<sub>2</sub> – fresh fertile fsc; D<sub>3</sub> – moist fertile fsc)**

**Note: B<sub>2</sub> – fresh relatively poor forest site conditions is not shown because of very low occurrence**

Comparison of the evaluation results by administrative regions shows that in C<sub>2</sub>–C<sub>3</sub> European ash has the worst survival in Sumy Region and the best in Poltava Region (Table 4).

*Table 4*

**Survival of European ash stands in the particular forest site conditions in the forest fund of analyzed forest enterprises of the Left-Bank Forest-Steppe grouped by regions (all origins and site index)**

Region	Average age	Survival up to age class, %					
		V	VI	VII	VIII	IX	X
<b>C<sub>2</sub> – C<sub>3</sub> – fresh and moist relatively fertile forest site conditions</b>							
Kharkiv	51	33.3	26.2	4.0	0.0	0.0	0.0
Sumy	33	0.0	0.0	0.0	0.0	0.0	0.0
Poltava	53	30.7	25.2	21.5	20.0	14.1	0.0
<b>D<sub>1</sub> – dry fertile forest site conditions</b>							
Kharkiv	72	81.6	70.1	47.5	40.8	0.0	0.0
Sumy	64	82.1	55.3	35.8	0.0	0.0	0.0
Poltava	47	41.9	30.8	2.6	2.6	0.0	0.0
<b>D<sub>2</sub> – fresh fertile forest site conditions</b>							
Kharkiv	63	56.3	33.9	25.2	14.8	13.6	5.9
Sumy	74	65.3	57.0	45.9	34.9	27.0	15.8
Poltava	63	69.9	49.0	29.5	12.4	4.8	1.3
<b>D<sub>3</sub> – moist fertile forest site conditions</b>							
Kharkiv	66	79.1	71.6	32.7	6.8	0.0	0.0
Sumy	81	74.1	64.6	53.1	52.5	49.7	42.9
Poltava	61	60.8	47.8	37.1	15.4	9.0	0.0

The average age class of ash stands is the highest in the forest-steppe part of Sumy Region in D<sub>2</sub> and D<sub>3</sub>, in the forest-steppe part of Kharkiv Region in D<sub>1</sub>, and in the forest-steppe part of Poltava

Region in C<sub>2</sub> and C<sub>3</sub>. In D<sub>1</sub> ash survival is the lowest in the forest-steppe part of Poltava Region and the highest in the forest-steppe part of Kharkiv Region. In D<sub>2</sub> and D<sub>3</sub> ash survival is the highest in the forest-steppe part of Sumy Region, which is most obvious in the VI–X and VII–X age classes respectively. In D<sub>3</sub> ash survival in the forest-steppe part of Kharkiv Region is higher than in the forest-steppe part of Poltava Region before VI age class (see Table 4).

Data grouping by stand origin shows that the predominant part of European ash grows in vegetative stands (Table 5). Artificial seed ash stands predominate in the forest fund of Kharkivska FRS (82.3 %), Gadyatske FE (77.9 %) and Gutyanske FE (57.6 %). Proportion of natural seed stands is low in most of analyzed forest enterprises with the highest values in Gadyatske FE (17.8 %), Trostyanetske FE (16 %), Poltavske FE (12.9 %) and Kharkivska FRS (10.7 %).

*Table 5*

**Distribution of area of European ash stands by stand origin in the forest fund of certain forest enterprises of the Left-Bank Forest-Steppe (all site index classes and forest site conditions)**

State Forest Enterprise (FE)	Distribution of area, %		
	natural seed	artificial seed	vegetative
Vovchanske FE	5.6	17.9	76.5
Kharkivska FRS	10.7	82.3	7.0
Gutyanske FE	0.2	57.6	42.2
Chuguevo-Babchanske FE	0.0	17.9	82.1
Zmiivske FE	4.5	13.3	82.2
Trostyanetske FE	16.0	23.1	60.9
Okhtyrskе FE	4.2	15.6	80.2
Gadyatske FE	17.8	77.9	4.3
Poltavske FE	12.9	17.8	69.3
Myrgorodske FE	7.9	33.3	58.8
Kharkiv Region *	2.8	21.9	75.3
Sumy Region *	8.0	18.0	74.0
Poltava Region *	11.2	36.2	52.6
Left-Bank Forest-Steppe *	6.8	23.1	70.1

\*Average for analyzed Forest Enterprises from each region or pooled data for Left-Bank Forest-Steppe.

A calculation shows that an average age of ash is the highest for the stands of artificial seed origin (75 years) in Kharkiv Region, of natural seed (86 years) and vegetative (77 years) origin – in Sumy Region (Fig. 2).

In the forest fund of analyzed forest enterprises of the Left-Bank Forest-Steppe, the most ash stands have the I site index class (Table 6). Only in the forest-steppe part of Kharkiv Region the II–III site index classes predominate (61.9 %). The largest proportion of ash stands with I<sup>a</sup>–I<sup>g</sup> site index class is in Trostyanetske FE and Okhtyrskе FE of Sumy Region (35.5 % and 32.7 % respectively) and in Gadyatske FE and Poltavske FE of Poltava Region (35.2 % and 29.5 % respectively), their less proportion is in Gutyanske FE and Kharkivska FRS of Kharkiv Region (28.4 % and 24.2 % respectively) (see Table 6).

*Table 6*

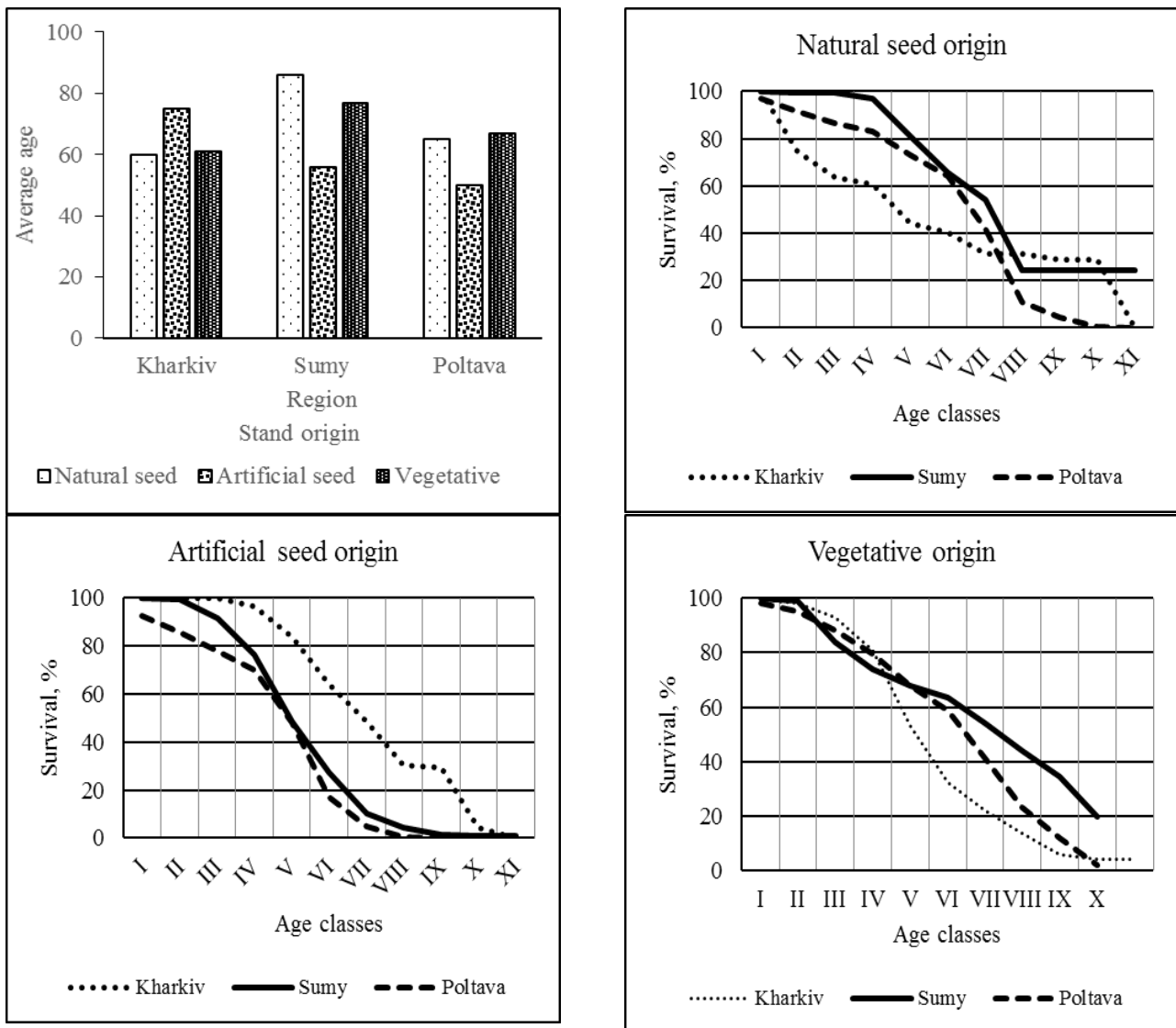
**Distribution of area of European ash stands by site index classes in the forest fund of certain forest enterprises of the Left-Bank Forest-Steppe (all stand origins and forest site conditions)**

State Forest Enterprise (FE)	Distribution of area, %			
	I <sup>a</sup> –I <sup>g</sup>	I	II–III	IV–V
Vovchanske FE	7.9	45.2	43.9	3.0
Kharkivska FRS	24.2	34.2	39.7	1.9
Gutyanske FE	28.4	46.4	25.2	0.0
Chuguevo-Babchanske FE	0.3	11.8	86.6	1.3

*Continuation of Table 6*

State Forest Enterprise (FE)	Distribution of area, %			
	I <sup>a</sup> -I <sup>g</sup>	I	II-III	IV-V
Zmiyivske FE	3.9	38.7	56.6	0.8
Trostanetske FE	35.5	55.7	8.5	0.3
Okhtyrsk FE	32.7	50.4	16.6	0.3
Gadyatske FE	35.2	54.3	10.5	0.0
Poltavske FE	29.5	42.4	27.6	0.5
Myrgorodske FE	19.0	50.9	30.0	0.1
Kharkiv Region *	6.2	30.3	61.9	1.6
Sumy Region *	33.5	52.1	14.1	0.3
Poltava Region *	25.1	48.9	25.8	0.2
Left-Bank Forest-Steppe *	22.3	43.8	33.2	0.7

\*Average for analyzed Forest Enterprises from each region or pooled data for Left-Bank Forest-Steppe.

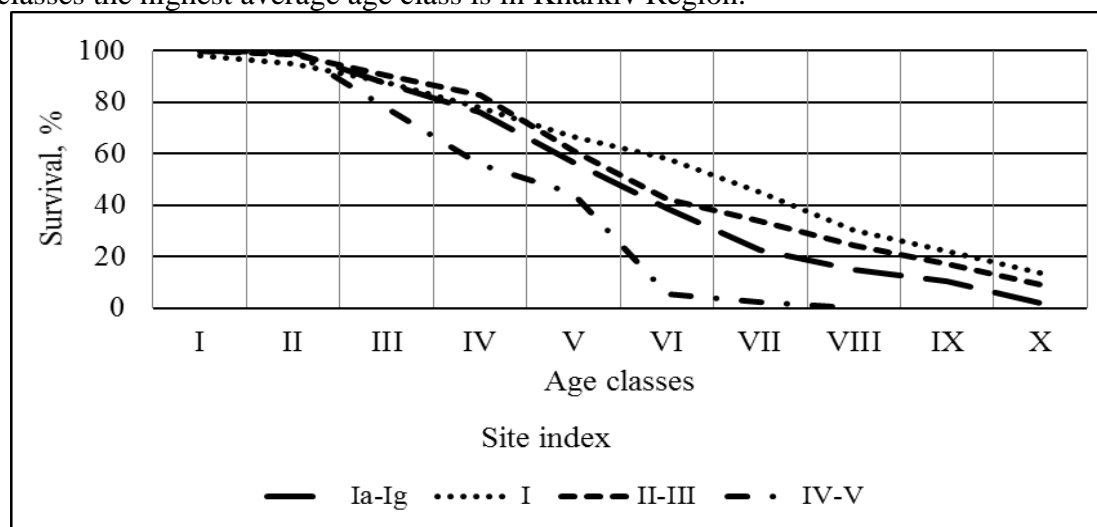


**Fig. 2 – Survival of European ash stands of different origins in analyzed forest enterprises of certain regions of the Left-Bank Forest-Steppe (all site index classes and forest site conditions)**

A comparison of survival for European ash stands of different site index classes shows that the stands of the worse growth have the least longevity (Fig. 3). At the same time, the stands of the best growth (site indices I<sup>a</sup>-I<sup>g</sup>) have lower survival than those of I-III site indices.

Such a conclusion is also true for certain regions (Table 7). The stands of European ash of IV-V site index classes survive in Poltava Region only up to III age class, in Sumy Region – up to

VI age class, and in Kharkiv Region – up to VII age class. At the same time, the stands of I<sup>a</sup>–I<sup>g</sup> site indices survive up to XIV age class only in Sumy Region. Average age class of European ash stands is the highest in Sumy Region for stands with I<sup>a</sup>–I<sup>g</sup> and I site indices. For ash stands with II–III site index classes the highest average age class is in Poltava Region and for ash stands with IV–V site index classes the highest average age class is in Kharkiv Region.



**Fig. 3 – Survival of European ash stands of particular site index classes in the forest fund of analyzed forest enterprises of the Left-Bank Forest-Steppe (all origins and forest site conditions)**

*Table 7*

**Survival of European ash stands of particular site index classes in the forest fund of analyzed forest enterprises of the Left-Bank Forest-Steppe grouped by regions (all origins and forest site conditions)**

Region	Average age	Survival up to age class, %									
		V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
Site indices I <sup>a</sup> –I <sup>g</sup>											
Kharkiv	59	55.3	35.0	12.5	0.3	0.3	0.0	0.0	0.0	0.0	0.0
Sumy	63	57.2	44.4	28.6	22.1	15.2	2.5	2.0	1.6	0.4	0.4
Poltava	55	56.0	22.8	9.2	0.5	0.0	0.0	0.0	0.0	0.0	0.0
Site index I											
Kharkiv	61	52.6	40.1	22.6	12.0	10.8	4.1	3.7	3.7	0.0	0.0
Sumy	84	75.3	69.7	60.9	46.0	36.2	23.5	16.6	13.0	10.0	9.6
Poltava	59	62.0	51.0	32.2	12.9	1.6	0.1	0.0	0.0	0.0	0.0
Site indices II – III											
Kharkiv	66	63.6	40.3	32.4	22.6	13.1	5.5	3.3	0.2	0.0	0.0
Sumy	65	49.4	41.2	32.9	27.4	25.8	25.0	2.2	0.2	0.2	0.0
Poltava	68	65.3	52.2	40.4	28.2	22.8	3.6	0.0	0.0	0.0	0.0
Site indices IV–V											
Kharkiv	53	54.7	7.2	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sumy	33	11.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Poltava	30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

In analyzed forest enterprises the most frequent ash proportion in the stand composition is 50–70 %, which varies from 47.5 % in Gadyatske FE to 68.9 % in Trostyanetske FE (Table 8). Pure ash stands are very rare in the Left-Bank Forest-Steppe. The stands with 80–100 % of ash make up 15.5 % on average in the Left-Bank Forest-Steppe, and from 10.3 % to 21.2 % in its different regions (see Table 8).

A comparison of European ash stands having different proportion of this species in the forest composition shows that survival of pure (100 % of European ash) and almost pure (80–90 % of European ash) stands sharply decreases after V age class (Fig. 4).

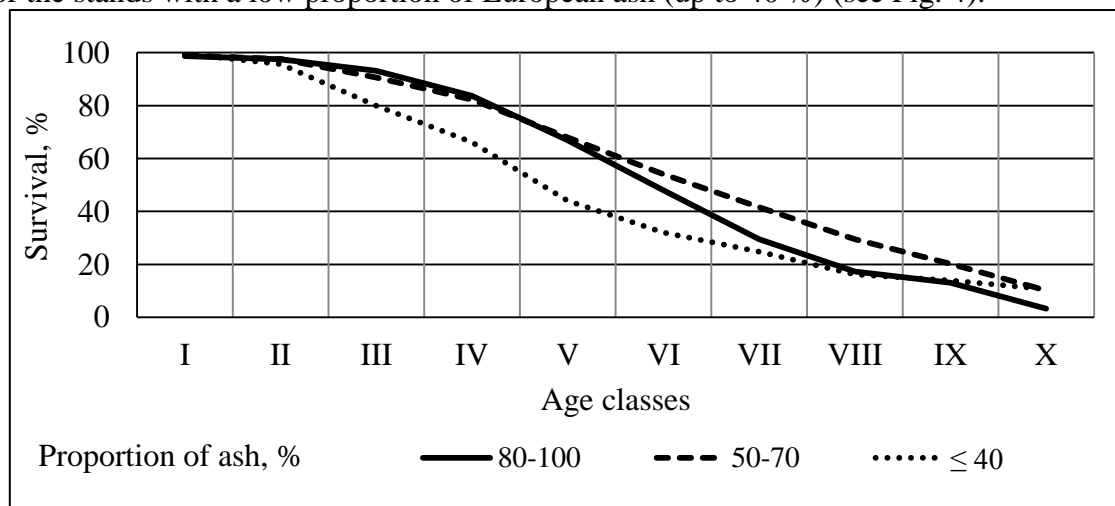
Table 8

**Distribution of the area of European ash stands by ash proportion in the forest composition in the forest fund of certain forest enterprises of the Left-Bank Forest-Steppe (all stand origins, forest site conditions and site indices)**

State Forest Enterprise (FE)	Distribution of area by ash proportion, %		
	80–100 % of ash	50–70 % of ash	10–40 % of ash
Vovchanske FE	24.3	60.3	15.4
Kharkivska FRS	23.3	59.6	17.1
Gutyanske FE	23.7	53.3	23.0
Chuguevo-Babchanske FE	22.5	61.6	15.9
Zmiyivske FE	12.2	64.0	23.8
Trostanetske FE	6.4	68.9	24.7
Okhtyrskе FE	12.1	64.5	23.4
Gadyatske FE	40.4	47.5	12.1
Poltavske FE	15.6	51.1	33.3
Myrgorodske FE	10.5	63.1	26.4
Kharkiv Region *	21.2	60.9	17.9
Sumy Region *	10.3	65.9	23.8
Poltava Region *	17.3	56.7	26.0
Left-Bank Forest-Steppe *	15.5	62.3	22.2

\*Average for analyzed Forest Enterprises from each region or pooled data for Left-Bank Forest-Steppe.

The highest survival was detected for the stands with 50–70% of European ash and the lowest one for the stands with a low proportion of European ash (up to 40 %) (see Fig. 4).



**Fig. 4 – Survival of ash stands with particular European ash proportion in the stand composition in the forest fund of analyzed forest enterprises of the Left-Bank Forest Steppe (all origins, site index classes, and forest site conditions)**

The average age of European ash stands in the analyzed forest enterprises of the Left-Bank Forest-Steppe is the highest in the mixed stands with 50–70 % of European ash, which makes up 71 years on average (Table 9). This conclusion is true for Sumy and Poltava Regions, however, in Poltava Region, this value is lower (79 and 64 years for Sumy and Poltava Regions respectively). The average age class of European ash stands in the analyzed forest enterprises of Kharkiv Region is the highest for forests with a greater proportion of ash (72 for stands with 80–100 % of ash).

The survival of pure and almost pure European ash stands is the highest in Kharkiv Region and the lowest in Poltava Region (Table 9). Survival of stands with 50–70 % of European ash is the highest in Sumy Region, especially after V age class. Survival of the stands with a low proportion of European ash (up to 40 %) is the highest in Kharkiv Region up to V age class, and then in Sumy Region. In Kharkov Region, plantations with a higher proportion of ash are characterized by the greatest survival for the entire period of growth. In Sumy Region, the stands with 50–70 % of



European ash are characterized by the greatest survival for the entire period of growth, and survival of pure and almost pure stands sharply decreases.

*Table 9*

**Survival of European ash stands with particular ash proportion in the stand composition in the forest fund of analyzed forest enterprises of the Left-Bank Forest-Steppe grouped by regions (all origins, site index classes and forest site conditions)**

Region	Average age	Survival up to age class, %							
		IV	V	VI	VII	VIII	IX	X	XI
European ash proportion is 80–100 %									
Kharkiv	72	90.8	77.7	54.9	40.6	26.5	24.4	6.1	0.0
Sumy	61	77.5	54.7	48.3	26.4	13.1	2.7	0.1	0.0
Poltava	56	76.9	60.0	33.0	10.1	3.2	2.9	1.3	0.0
European ash proportion is 50–70 %									
Kharkiv	64	83.2	58.4	40.2	28.7	18.9	9.4	5.5	4.1
Sumy	79	82.4	73.9	64.8	53.0	42.3	32.8	17.6	9.8
Poltava	64	80.2	70.8	52.1	36.7	16.8	7.7	0.0	0.0
European ash proportion is up to 40%									
Kharkiv	54	77.5	41.9	18.0	9.2	2.9	2.7	0.1	0.0
Sumy	65	58.2	46.8	39.2	34.9	25.2	24.0	20.7	13.5
Poltava	57	68.7	41.2	34.1	22.8	14.0	7.2	2.8	0.0

In suggested maturity age (VIII age class (Shvidenko et al. 1987)) survival of European ash with its proportion of 80–100 % is 26.5 %, 13.1 % and 3.2 % in Kharkiv, Sumy and Poltava Regions respectively. Survival of stands with 50–70 % of European ash in such age is 18.9 %, 42.3 % and 16.8 % in Kharkiv, Sumy and Poltava Regions respectively, and those of stands with 10–40 % of European ash is 2.9 %, 25.2 % and 14 % (see Table 9).

Considering ash stands low survival, the age of the main felling in forests that are possible for exploitation can be reduced since a large volume of high-quality wood is lost as a result of forest damage by different causes. However, in other categories of forests, the trees can provide ecological functions for several decades while they are still alive and even after death. Moreover, in the disease foci, single surviving trees, which are usually harvested during clear-felling, can be a source of natural selection of resistant individuals.

**Conclusions.**

1. The average age of ash stands is 68 years for the Left-Bank Forest Steppe. It is the largest in Sumy Region (74 years), the lowest in Poltava Region (60 years) and is 64 years for Kharkiv Region. On average from 46.1 % (Poltavske FE) to 81.6 % (Kharkivska FRS) of European ash stands survive up to the V age class.

2. The average age of ash stands is the highest in the forest-steppe part of Sumy Region in fresh fertile and moist fertile forest site conditions, in the forest-steppe part of Kharkiv Region in dry fertile forest site conditions, and in the forest-steppe part of Poltava Region in fresh and moist relatively fertile forest site conditions.

3. Artificial seed ash stands predominate in the forest fund of Kharkivska FRS (82.3 %), Gadyatske FE (77.9 %) and Gutyanske FE (57.6 %). An average age of European ash is the highest (75 years) in artificial seed stands in Kharkiv Region, in natural seed (86 years) and vegetative (77 years) origin in Sumy Region.

4. The highest survival rate was detected for the stands with 50–70 % proportion of European ash. The survival of pure and almost pure European ash stands is the highest in Kharkiv Region and the lowest in Poltava Region.

5. In the legislatively adopted maturity age (VIII age class) survival of European ash with its proportion of 80–100 % is 26.5 %, 13.1 % and 3.2 % in Kharkiv, Sumy and Poltava Regions respectively. Correction of the age of the main felling in forests that are possible for exploitation is suggested considering the possible loss of timber quality as a result of forest damage by different causes.

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ВІКОВА СТРУКТУРА НАСАДЖЕНЬ ЯСЕНА ЗВИЧАЙНОГО (*FRAXINUS EXCELSIOR* L.) У ЛІВОБЕРЕЖНОМУ ЛІСОСТЕПУ УКРАЇНИ

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Проаналізовано вікову структуру насаджень ясен звичайного в лісовому фонді лісгосподарських підприємств Сумської, Харківської та Полтавської областей з урахуванням лісорослинних умов, походження насаджень, бонітету та участі ясен в складі. Середній вік ясен звичайного в Лівобережному лісостепу становить 68 років. Від 46,1 до 81,6 % ясеневих насаджень доживають до V класу віку. Середній вік ясеневих насаджень є найбільшим у лісостеповій частині Сумської області у D<sub>2</sub> та D<sub>3</sub>, у Харківській – у D<sub>1</sub>, а у Полтавській – у C<sub>2</sub> та C<sub>3</sub>. Цей показник є найбільшим (75 років) у штучних насінневих насадженнях Харківської області, у природних насінневого (86 років) та вегетативного (77 років) походжень Сумської області. Збереженість чистих і майже чистих ясеневих насаджень є найбільшою у Харківській області та найменшою у Полтавській. У законодавчо встановленому віці стиглості (VIII клас віку) збереженість насаджень із участю 8–10 одиниць ясен становить 26,5; 13,1 і 3,2 % у Харківській, Сумській і Полтавській областях відповідно. Пропонується скоригувати вік рубки головного користування у лісах, можливих для експлуатації, з урахуванням імовірного зниження якості деревини внаслідок пошкодження лісу різними чинниками.

Ключові слова: ясен звичайний (*Fraxinus excelsior* L.), лісорослинні умови, походження насаджень, бонітет, участь ясен у складі насаджень.

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ВОЗРАСТНА СТРУКТУРА НАСАДЖЕНЬ ЯСЕНЯ ОБЫКНОВЕННОГО (*FRAXINUS EXCELSIOR* L.) В ЛІВОБЕРЕЖНОМУ ЛІСОСТЕПУ УКРАЇНИ

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Ключевые слова: ясен обыкновенный (*Fraxinus excelsior* L.), лісорослинні умови, походження насаджень, бонітет, участь ясен в складі насаджень.

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