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Productivity of fodder grasses in the conditions of the Southern Forest Steppe of Ukraine

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Legume-cereal grasses provide an opportunity to significantly increase the productivity of grasslands. The economic value of plants on natural fodder grounds is determined by their productivity. The bird's-foot trefoil and crested weat grass have high fodder value. Among the fodder leguminous grasses, the bird's-foot trefoil is one of the most valuable pasture plants. This plant is a good component of the grass mixture, which ensures the accumulation of root mass. The crested weat grass is a fodder cereal that is also widely used in grass mixtures. Therefore, the urgency of the topic lies in the need to analyze collection samples of the bird's-foot trefoil and weat grasses for fodder and seed productivity in the conditions of the Southern Forest Steppe of Ukraine. This is important for finding good initial material in analytical selection breeding and solving the problem of seed production. The purpose of the research is to find out the adaptive potential of collection samples of the bird's-foot trefoil and weat grasses to reveal the productivity of these perspective fodder grasses. The research was conducted at the Ustymivka Experimental Station of Plant growing of the Institute of Plant growing named after V. Ya. Yuriev of NAAS of Ukraine in 2022–2023. The object of the research was 21 collection samples of the bird's-foot trefoil and 23 collection samples of weat grasses, among which there were crested weat grass and desert weat grass. As a result of the research, an assessment of the collection samples of the bird's-foot trefoil was carried out according to the yield of green mass, hay and seeds. The best collection samples of UJ0500012, UJ0500100, UJ0500110 and UJ0500112 were selected for the yield of green mass (respectively 2063.80 g/m^2, 1798.0 g/m^2, 2200.40 g/m^2, 2262.30 g/m^2) and hay (respectively 481.80 g/m^2, 439.0 g/m^2, 557.10 g/m^2, 576.10 g/m^2). Collection samples of weat grasses were assessed for height before mowing, productivity of green mass after mowings, hay productivity after mowings, and seed productivity. The best sample of crested weat grass UDS00039 was selected out for the height of the plant before mowing (70.6 cm), the yield of green mass (810.1 g/m^2) and the yield of hay (272.5 g/m^2). The best collection samples of crested weat grass UDS00070, UDS00073, UDS00074 were selected for the yield of green mass (respectively 778 g/m^2, 962.8 g/m^2, 753.3 g/m^2) and hay (respectively 255.2 g/m^2, 344.7 g/m^2, 270.5 g/m^2). The best collection samples of crested weat grass UDS00076 and UDS00081 were selected for plant height before mowing (67.3 cm and 66.9 cm, respectively) and hay yield (259 g/m^2 and 256.9 g/m^2, respectively). The desert weat grasses sample UDS00018 also performed well in terms of plant height before mowing (65.3 cm) and seed yield (107.5 g/m^2). Selected collection samples of the bird's-foot trefoil and weat grasses are recommended as initial material for analytical selection.

Keywords: bird's-foot trefoil, crested and desert weat grass, collection samples, height of the plant before mowing, yield of green mass, hay and seeds.

Продуктивність кормових трав в умовах Південного Лісостепу України

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Бобово-злакові травостої дають можливість істотно підвищити продуктивність лучних угідь. Господарська цінність рослин на природних кормових угіддях визначається їх продуктивністю. Лядвенець рогатий і житняк гребінчастий мають високу кормову цінність. Серед кормових бобових трав лядвенець рогатий є однією з найцінніших пасовищних рослин. Ця рослина є гарним компонентом травосумішки, що забезпечує нагромадження кореневої маси. Житняк гребінчастий є кормовим злаком, що також широко використовується у травосумішках. Тому актуальність теми полягає у необхідності аналізу колекційних зразків лядвенцю рогатого і житняків на кормову і насіннєву продуктивність в умовах Південного Лісостепу України. Це важливо для пошуку гарного вихідного матеріалу в аналітичній селекції та вирішення проблеми насінництва. Мета досліджень – з'ясувати адаптивний потенціал колекційних зразків лядвенцю рогатого і житняків для вияву продуктивності цих перспективних кормових трав. Дослідження проводилися на Устимівській дослідній станції рослинництва Інституту рослинництва імені В. Я. Юр'єва НААН України у 2022–2023 роках. Об'єктом дослідження був 21 колекційний зразок лядвенцю рогатого і 23 колекційних зразки житняків, серед яких був житняк гребінчастий та житняк пустельний. У результаті досліджень здійснено оцінку колекційних зразків лядвенцю рогатого за урожайністю зеленої маси, сіна і насіння. Виділено найкращі колекційні зразки лядвенцю рогатого UJ0500012, UJ0500100, UJ0500110 і UJ0500112 за урожайністю зеленої маси (відповідно 2063,80 г/м^2, 1798,0 г/м^2, 2200,40 г/м^2, 2262,30 г/м^2) і сіна (відповідно 481,80 г/м^2, 439,0 г/м^2, 557,10 г/м^2, 576,10 г/м^2). Здійснено оцінку колекційних зразків житняків за висотою перед укосом, урожайністю зеленої маси за укосами, урожайністю сіна за укосами і урожайністю насіння. Виділено найкращий зразок житняку гребінчастого UDS00039 за висотою рослини перед укосом (70,6 см), за урожайністю зеленої маси (810,1 г/м^2) і за урожайністю сіна (272,5 г/м^2). Виділено кращі колекційні зразки житняку гребінчастого UDS00070, UDS00073, UDS00074, за урожайністю зеленої маси (відповідно 778 г/м^2, 962,8 г/м^2, 753,3 г/м^2) і сіна (відповідно 255,2 г/м^2, 344,7 г/м^2, 270,5 г/м^2). Виділено кращі колекційні зразки житняку гребінчастого UDS00076 і UDS00081 за висотою рослини перед укосом (відповідно 67,3 см і 66,9 см) і урожайністю сіна (відповідно 259 г/м^2 і 256,9 г/м^2). Також гарно себе проявив зразок житняку пустельного UDS00018 за висотою рослини перед укосом (65,3 см) і за урожайністю насіння (107,5 г/м^2). Виділені колекційні зразки лядвенцю рогатого і житняків рекомендуються як вихідний матеріал для аналітичної селекції.

Ключові слова: лядвенець рогатий, гребінчастий і пустельний житняки, колекційні зразки, висота рослини перед укосом, урожайність зеленої маси, сіна і насіння.

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Introduction

After the end of this terrible war, Ukraine will need the restoration of natural fodder lands and the creation of highly productive sown pastures and hayfields. The Bible says that in time God will plant many plants in the territories that suffered from destruction. "And the earth shall yield her increase" and "I will raise up for them a plant of renown" [1]. V. Petrychenko and V. Kurgak claim that "the creation of sown leguminous-cereal grass stands on meadows makes it possible to significantly increase their productivity, protein content and energy content and significantly reduce the consumption of technical nitrogen" [2].

As O. Zinchenko, G. Demidas and A. Sichkar rightly note, "meadow fodder production is a source of high-quality fodder" [3]. "Perennial leguminous grasses guarantee the entry of organic mass into the soil environment, and with it, the main elements of plant nutrition, much more than annual fodder plants" [4]. It enriches soil fertility. Cereal perennial grasses are also an important component of meadow fodder production. On a cereal pasture, animals have sufficient amounts of the necessary nutrients. In terms of nutrition, 1 kg of cereal grass on pastures and hayfields corresponds to 0.22 fodder units. V. Vlokh, N. Kyrychenko and P. Kogut noted that "in green mass and hay collected in the early stages of grass development, there are many vitamins A, B_1, B_2 and C important for animals" [5].

The economic value of plants on natural fodder grounds is determined by their productivity. As noted by L. Yermakova, R. Ivanovska and M. Shevnikov, "the feed value depends on the biochemical composition of the green mass, in particular the content of protein, fat, fiber, ash elements, biologically active substances, animal consumption and digestibility" [6]. The bird's-foot trefoil and crested weat grass have high fodder value.

Among the forage leguminous grasses, the bird's-foot trefoil is one of the most valuable pasture plants. It is a good component of the grass mixture, which ensures the accumulation of root mass. V. Bugaiov notes that bird's-foot "combines well with all other plants on both acidic and normal soils. This perennial leguminous plant perfectly forms a vegetative mass and a huge number of flowers. It can withstand 3–4 mowings. The bird's-foot trefoil acts as a poison against slugs and snails. This is an unsurpassed sidereal culture" [7]. It "is characterized by high productivity and quality of fodder, durability, and resistance to trampling. The dry matter contains 23.2 % protein, 9.2 % fat and a relatively low percentage (23.1%) of fiber" [8]. This plant is an excellent honey bearer. When the bees are not yet flying, the flowering bird's-foot is pollinated by bumblebees and other insects.

The grazing of cattle on pastures where the bird's-foot grows leads to the production of delicious milk and high-quality cheese. The hay from the bird's-foot does not cause bloating in livestock. V. Nikolaychuk, I. Feketa, and I. Grigoryuk note that "one of the most valuable biological properties of the bird's-foot trefoil is its unpretentiousness to environmental conditions" [9]. I. Hryhoriuk discovered the sensitivity of the bird's-foot trefoil to the conditions of the soil environment, which affects its ability to withstand low temperatures [10]. G. Birta and Y. Burgu claim that "this is a moisture-loving plant and can withstand flooding with water for up to 30 days" [11]. F. Escaraya et al. note that «some of the bird's-foot species show a great potential for adaptation to a number of abiotic stresses. Therefore, they are relevant components of grassland ecosystems in environmentally constrained areas of several South American countries and Australia, where they are used for livestock production» [12].

V. Olifirovych, V. Osadchuk, O. Chinchyk, and V. Kravchenko note that "the root mass accumulation occurred more slowly on the grassy stand of the bird's-foot trefoil with timothy. In the soil layer of 0–30 cm, the mass was 8.33 t/ha. Cultivation of a grass mixture of bird's-foot trefoil with smooth brome spike contributed to an increase in the amount of root mass by 0.42–0.80 t/ha compared to cultivation of a grass mixture of bird's-foot trefoil with timothy" [13].

Ukrainian scientists studied the influence of the ratio of leaf mass to stem mass on individual indicators of biochemical composition, nutrition and productivity of *Lotus corniculatus* L. by phenological phases [14]. N. Dobryanska and G. Galatovych studied the influence of sowing dates and methods on the seed yield and fodder mass of the variety bird's-foot trefoil Verkhovynets in the conditions of Precarpathia [15]. The authors of the article analyzed the collection samples of bird's-foot trefoil for fodder qualities for 2022 and 2023 [16].

The crested weat grass is a fodder cereal that is widely used in grass mixtures with alfalfa to create cultivated hayfields and pastures. The yield of hay is up to 30 c/ha. 100 kg of hay corresponds to 53 fodder units and 4 kg of digestible protein. In 1896, V. Bohdan introduced this cereal into culture for the first time. The crested weat grass is a drought-resistant and winter-hardy plant. It is an early-ripening cereal and therefore is well used by animals in the spring. This plant is resistant to trampling and grazing. In Ukraine, crested weat grass grows in the southern part of the Forest-Steppe, Steppe and in mountainous areas.

This plant has long been used in the steppes and meadows of the USA and Canada. «Seedling emergence in crested wheatgrass was shown to be enhanced by inoculation with the soil diazotroph *Bacillus polymyxa*» [17]. Scientists from North America claim that crested wheatgrass can be used to restore pastures. «It increases rangeland carrying capacity, readily establishes from seed, has excellent drought resistance and winterhardiness, provides high quality early spring and fall feed, and produces substantially more forage yield than native species» [18]. S. Wilson and B. Vaness studied the distribution of crested wheatgrass in the local prairies in the northern Great Plains [19]. K. Davies, J. Bates, C. Boyd investigated the ability of crested wheatgrass to invade and exclude native vegetation by drill seeding crested wheatgrass into intact sagebrush steppe understories at five sites [20].

Therefore, the urgency of the topic lies in the need to analyze collection samples of the bird's-foot trefoil and weat grasses for fodder and seed productivity in the conditions of the Southern Forest Steppe of Ukraine. This is important for finding good starting material in analytical breeding and solving the problem of seed production.

The aim of the study

The purpose of the research is to find out the adaptive potential of collection samples of the bird's-foot trefoil and weat grasses to reveal the productivity of these perspective fodder grasses.

In order to achieve the set goal, the following tasks must be solved:

1) to evaluate the collection samples of the bird's-foot trefoil in terms of yield of green mass, hay and seeds;

2) to evaluate the collection samples of weat grasses according to the height before mowing, yield of green mass after mowings, yield of hay after mowings and seed yield.

Materials and methods

Research was conducted on the Ustymivka Experimental Station of Plant growing of the Institute of Plant growing named after V. Ya. Yuriev of NAAS of Ukraine (Ustymivka ESP) in 2022–2023. The station is located in the southern part of the Forest Steppe of Ukraine. The soils are represented by medium loamy, saline, powerful chernozem with a humus content of up to 3.84 %. The research station is located on the border of the central warm zone of insufficient moisture and the southern warm arid zone. Therefore, this area is subject to the harmful effects of droughts. The climate at the station is moderately continental, with unstable humidity. The average long-term air temperature is 8.2 ^{0}C. The amount of precipitation varies from 253.8 mm to 777.4 mm per year.

The object of the research is 21 collection samples of the bird's-foot trefoil and 23 collection samples of weat grasses. In the collection samples were a crested weat grasses and a desert weat grasses. The length of the plot, on which the bird's-foot trefoil and weat grasses grow, is 5 m, the width is 1.4 m. Sowing took place in a row method with a row spacing of 0.70 m. Phenological observations and biometric analysis of collection samples are organized according to the method of conducting examination of plant varieties [21].

Results and discussion

As evidenced by the data in ***Table 1***, as a result of the study, the evaluation of the collection samples of the bird's-foot trefoil in an average of two years showed that in terms of the yield of green mass, the best samples were UJ0500112 (2262.30 g/m^2), UJ0500110 (2200.40 g/m^2), UJ0500012 (2063.80 g/m^2) and UJ0500100 (1798.0 g/m^2). Samples UJ0500019 (818.50 g/m^2), UJ0500030 (919.35 g/m^2), UJ0500006 (921.35 g/m^2) and UJ0500032 (971.30 g/m^2) performed the worst.

Determining the yield of hay in an average of two mowings and in an average of two years, the collection samples UJ0500112 (576.10 g/m^2), UJ0500110 (557.10 g/m^2), UJ0500012 (481.80 g/m^2), UJ0500100 (439.0 g/m^2), UJ0500055 (427.10 g/m^2) and UJ0500118 (418.0 g/m^2) showed themselves to be the best. Samples UJ0500019 (175.70 g/m^2), UJ0500030 (188.5 g/m^2) and UJ0500006 (199.85 g/m^2) had the lowest indicator.

The collection samples UJ0500006 (155.40 g/m^2), UJ0500030 (140.75 g/m^2), UJ0500007 (134.95 g/m^2) and UJ0500019 (134.44 g/m^2) was revealed by the highest yield of seeds from the plot on average for 2022–2023. The lowest seed yield was recorded in samples UJ0500014 (63.67 g/m^2), UJ0500009 (75.99 g/m^2), UJ0500100 (82.30 g/m^2), UJ0500118 (88.10 g/m^2) and UJ0500055 (89.80 g/m^2).

Table 1

Productivity of collection samples of the bird's-foot trefoil on average for 2022–2023

No. according to the national catalog	Yield, g/m2		
	green mass	hay	seeds
UJ0500006	921.35	199.85	155.40
UJ0500007	1207.05	258.50	134.95
UJ0500009	1019.90	232.80	75.99
UJ0500012	2063.80	481.80	95.70
UJ0500014	1328.50	289.90	63.67
UJ0500019	818.50	175.70	134.44
UJ0500023	1199.95	258.45	122.20
UJ0500024	1137.05	252.75	120.45
UJ0500026	1095.65	262.75	97.86
UJ0500030	919.35	188.5	140.75
UJ0500032	971.30	222.80	122.10
UJ0500033	1228.50	267.05	110.75
UJ0500055	1699.50	427.10	89.80
UJ0500100	1798.0	439.0	82.30
UJ0500110	2200.40	557.10	109.30
UJ0500111	1542.80	337.60	116.90
UJ0500112	2262.30	576.10	106.10
UJ0500114	1322.80	308.50	129.50
UJ0500118	1655.60	418.0	88.10
UJ0500119	1376.60	351.90	105.80
UJ0500122	1468.50	386.60	95.60

So, comparing the results of an average of two years of studies on the productivity of collection samples of the bird's-foot trefoil, the best samples UJ0500012, UJ0500100, UJ0500110 and UJ0500112 were selected for the yield of green mass and hay.

Table 2 presents 23 collection samples of the weat grasses. Of them, 18 samples of crested weat grass and 5 samples of desert weat grass (UDS00014, UDS00015, UDS00016, UDS00018, UDS00066). As evidenced by the data in Table 2, as a result of the study, the assessment of collection samples of weat grasses over an average of two years showed that in terms of plant height before mowing, the crested weat grass UDS00030 (71.5 cm), UDS00039 (70.6 cm), UDS00010 (68 cm), UDS00076 (67.3 cm) and UDS00081 (66.9 cm) showed their best. Among desert weat grasses, only sample UDS00018 had a good result (65.3 cm). The worst indicator was in sample UDS00093 (46.7 cm). It is appropriate to compare the results of studies of collection samples of weat grasses in terms of productivity.

In terms of the yield of green mass in an average of two years, collection samples of weat grass UDS00073 (962.8 g/m^2), UDS00039 (810.1 g/m^2), UDS00070 (778 g/m^2) and UDS00074 (753.3 g/m^2) were the best. The lowest yield of green mass was given by the sample of crested weat grass UDS00020 (389.2 g/m^2). Three samples of desert weat grass also gave a low yield of green mass. These are UDS00014 (392.3 g/m^2), UDS00066 (434.9 g/m^2) and UDS00015 (467.5 g/m^2).

Table 2
Productivity of collection samples of the weat grasses on average for 2022–2023

No. according to the national catalog	plant height before mowing, cm	Yield, g/m^2		
		green mass	hay	seeds
UDS00009	55.4	547.6	223.8	58.4
UDS00010	68	558.5	225.8	60
UDS00017	64.5	506.4	174.2	83.3
UDS00020	54.9	389.2	116.1	89.7
UDS00030	71.5	677.6	234.2	84.9
UDS00039	70.6	810.1	272.	84
UDS00042	56.	588.6	220.9	87.7
UDS00054	53.1	573.1	182.3	77.9
UDS00063	53.1	697.0	229.3	98.5
UDS00070	53.8	778.0	255.2	84.4
UDS00073	63.9	962.8	344.7	80.4
UDS00074	60.8	753.3	270.5	54.2
UDS00076	67.3	703.8	259	72.8
UDS00081	66.9	665.2	256.9	86.7
UDS00088	55.1	580.8	246.7	63.6
UDS00093	46.7	652.3	251.4	65.4
UDS00096	61.9	579.1	341.8	64.8
UDS00098	53.3	705.1	243.	56.5
UDS00014	52.5	392.3	133.9	44.4
UDS00015	56.5	467.5	141.8	61.9
UDS00016	62	507.5	179	73.6
UDS00018	65.3	645.5	207.5	107.5
UDS00066	52.3	434.9	192.3	120.5

Determining the yield of hay in an average of two mowings and in an average of two years, the collection samples UDS00073 (344.7 g/m^2), UDS00039 (272.5 g/m^2), UDS00074 (270.5 g/m^2), UDS00076 (259 g/m^2). UDS00081 (256.9 g/m^2) and UDS00070 (253.2 g/m^2) showed their best. Collection samples of crested weat grass UDS00020 (116.1 g/m^2) and two samples of desert weat grass UDS00014 (133.9 g/m^2) and UDS00015 (141.8 g/m^2) showed themselves to be the worst.

Two samples of desert weat grass UDS00066 (120.5 g/m^2) and UDS00018 (107.5 g/m^2) and a sample of crested weat grass UDS00063 (89.5 g/m^2) were found for the highest seed yield from the plot in 2022–2023. The desert weat grass UDS00014 (44.4 g/m^2) gave the lowest seed yield from the plot.

So, comparing the results of an average of two years of research on the productivity of collection samples of weat grasses, the best sample of crested weat grass UDS00039 was selected. The samples of crested weat grass UDS00070, UDS00073, UDS00074, UDS00076, UDS00081 and desert weat grass UDS00018 also performed well.

Conclusions

The study of fodder and seed productivity of the bird's-foot trefoil and weat grasses will affect the productivity improvement of meadows and pastures in Ukraine. It is advisable to use these plants for the creation of cultural pastures and hayfields and their restoration after the war. As a result of the research for 2022–2023, the adaptive potential of collection samples of the bird's-foot trefoil and weat grasses was clarified to reveal the productivity of these perspective fodder grasses.

1. An evaluation of the collection samples of the bird's-foot trefoil was carried out according to the yield of green mass, hay and seeds. The best collection samples of UJ0500012, UJ0500100, UJ0500110 and UJ0500112 were selected for the yield of green mass (respectively 2063.80 g/m^2, 1798.0 g/m^2, 2200.40 g/m^2, 2262.30 g/m^2) and hay (respectively 481.80 g/m^2, 439.0 g/m^2, 557.10 g/m^2, 576.10 g/m^2).

2. Collection samples of weat grasses were assessed for height before mowing, yield of green mass after mowings, hay productivity after mowings and seed yield. The best sample of the crested weat grass UDS00039 was selected out for the height of the plant before mowing (70.6 cm), the yield of green mass (810.1 g/m^2) and the yield of hay (272.5 g/m^2). The best collection samples of the crested weat grass UDS00070, UDS00073, UDS00074 were selected for the yield of green mass (respectively 778 g/m^2, 962.8 g/m^2, 753.3 g/m^2) and hay (respectively 255.2 g/m^2, 344.7 g/m^2, 270.5 g/m^2). The best collection samples of the crested weat grass UDS00076 and UDS00081 were selected for plant height before mowing (67.3 cm and 66.9 cm, respectively) and hay yield (259 g/m^2 and 256.9 g/m^2, respectively). The desert weat grass UDS00018 also performed well in terms of plant height before mowing (65.3 cm) and seed yield (107.5 g/m^2).

Selected collection samples of the bird's-foot trefoil and weat grasses are recommended as initial material for analytical selection.

Conflict of interest

The authors state that there is no conflict of interest.

References

1. King James Version of the Bible. (n.d.). [dataset]. In Religion Past and Present. Brill. https://doi.org/10.1163/1877-5888_rpp_dum_11577
2. Petrychenko, V. F., & Kurhak, V. H. (2013). *Kulturni sinozhati ta pasovyshcha Ukrainy*. Kyiv: Ahrarna nauka [in Ukrainian]
3. Zinchenko, O. I., Demydas, H. I., & Sichkar, A. O. (2014). *Kormovyrobnytstvo*. Vinnytsia: TOV «Nilan-LTD» [in Ukrainian]
4. Sobko, M. H, Sobko, N. A., & Sobko, O. M. (2012). Rol bahatorichnykh bobovykh trav u pidvyshchenni rodiuchosti gruntu. *Kormy i kormovyrobnytstvo*, 74, 53–57. [in Ukrainian]
5. Vlokh, V. H., Kyrychenko, N. Ia., & Kohut, P. M. (2003). *Lukivnytstvo*. Kyiv: Urozhai. [in Ukrainian]
6. Iermakova, L. M., Ivanovska, R. T., & Shevnikov, M. Ia. (2008). *Kormovyrobnytstvo*. Kyiv: Intas [in Ukrainian]
7. Buhaiov, V. (2023). Dyvo: liadvenets rohatyi. *«SontseSad»*, 2. [in Ukrainian]
8. Baystruk-Hlodan, L., Konyk, H., Khomiak, M., & Zhapaleu, H. (2020). Evaluation of the *Lotus corniculatus* L. breeding material on slope lands of the Carpathian region. *Foothill and Mountain Agriculture and Stockbreeding*, (68) 2, 8–23. https://doi.org/10.32636/01308521.2020-(68)-2-1
9. Nikolaichuk, V. I., Feketa, I. Iu., & Hryhoriuk, I. P. (2003). Zymostiikist *Lotus corniculatus* L.v umovakh Karpat. *Naukovyi Visnyk Uzhhorodskoho Natsionalnoho Universytetu. Seriia Biolohiia*, 13, 48–50. [in Ukrainian]
10. Hryhoriuk, I. P. (2006). Osoblyvosti zrostannia liadventsiu rohatoho na hruntakh vysokohiria Zakarpattia. *Ahrarna Nauka i Osvita*, 7 (3-4), 61–65. [in Ukrainian]
11. Birta, H. O., & Burhu, Yu. H. (2014). *Osnovy roslynnytstva i tvarynnytstva*. Kyiv: Tsentr uchbovoi literatury [in Ukrainian]
12. Escaray, F. J., Menendez, A. B., Gárriz, A., Pieckenstain, F. L., Estrella, M. J., Castagno, L. N., Carrasco, P., Sanjuán, J., & Ruiz, O. A. (2012). Ecological and agronomic importance of the plant genus Lotus. Its application in grassland sustainability and the amelioration of constrained and contaminated soils. *Plant Science*, 182, 121–133. https://doi.org/10.1016/j.plantsci.2011.03.016
13. Olifirovich, V. O., Osadchuk, V. D., Chynchyk, A. S., & Kravshenko, V. S. (2018). Accumulation of the root mass of the leguminous grass, due to the composition of the mixture and fertilizer. *Collected Works of Uman National University of Horticulture*, 201–208. https://doi.org/10.31395/2415-8240-2018-93-1-201-208

14. Kovtun, K. P., Veklenko, Yu. A., Korniichuk, O. V., & Babych-Poberezhna, A.A. (2020). Biokhimichnyi sklad i kormova produktyvnist liadventsiu rohatoho *Lotus corniculatus* L. v umovakh Pravoberezhnoho Stepu Ukrainy. *Norwegian Journal of development of the International Science*, 45, 4–7. [in Ukrainian]
15. Dobrianska, N. A., & Halatovych, H. Ia. (2010). Formuvannia vrozhaiu nasinnia ta kormovoi produktyvnosti liadventsiu rohatoho zalezhno vid sposobiv i strokiv sivby. *Selektsiia i Nasinnytstvo*,98, 220–227. https://doi.org/10.30835/2413-7510.2010.70295 [in Ukrainian]
16. Antonets, O. A., & Kocherha, V. Ia. (2024). Kormova ta nasinnieva produktyvnist kolektsiinykh zrazkiv liadventsiu rohatoho. *«Luchni ahrofitotsenozy: innovatsiini aspekty ratsionalnoho vykorystannia v umovakh yevrointehratsii»: Materialy Vseukrainskoi naukovo-praktychnoi konferentsii* (s. Obroshyne, 5 chervnia 2024 r.) (pp. 3–5.) Lviv-Obroshyne [in Ukrainian]
17. Holl, F. (1988). Response of crested wheatgrass (*Agropyron cristatum* L.), perennial ryegrass (*Lolium perenne* and white clover (*Trifolium repens* L.) to inoculation with Bacillus polymyxa. *Soil Biology and Biochemistry*, 20 (1), 19–24. https://doi.org/10.1016/0038-0717(88)90121-6
18. Robins, J. G., & Jensen, K. B. (2020). Breeding of the *Crested wheatgrass* complex (*Agropyron* spp.) for North American temperate rangeland agriculture and conservation. *Agronomy*, 10 (8), 1134. https://doi.org/10.3390/agronomy10081134
19. Vaness, B. M., & Wilson, S. D. (2007). Impact and management of crested wheatgrass (*Agropyron cristatum*) in the northern Great Plains. *Canadian Journal of Plant Science*, 87 (5), 1023–1028. https://doi.org/10.4141/cjps07120
20. Davies, K. W., Bates, J. D., & Boyd, C. S. (2023). Is *Crested wheatgrass* invasive in Sagebrush Steppe with Intact Understories in the Great Basin? *Rangeland Ecology & Management*, 90, 322–328. https://doi.org/10.1016/j.rama.2023.03.004
21. Tkachyk, S. O. (Red.). (2017). *Metodyka provedennia ekspertyzy sortiv roslyn hrupy tekhnichnykh ta kormovykh na prydatnist do poshyrennia v Ukraini*: 3-tie vydannia, vypravlene i dopovnene. Vinnytsia: FOP Korzun D. Yu. [in Ukrainian]

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