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ADAPTABILITY, SUSTAINABILITY AND PRODUCTIVITY OF MID-EARLY SOYBEAN VARIETIES

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Relevance. Soybeans are a source of affordable plant-based proteins that can be used as food, fodder for livestock or raw material for technical needs. This explains a constant increase in the sowing area of soybean varieties. The United States, Brazil and Argentina are the largest soybean-producing countries. Soybeans are grown mainly on fertile soils with a proper level of moisture and heat, in the so-called soybean belt [1].

Ukraine has great potential for increasing both its sowing area and the yield of soybeans. Favourable regions for cultivating soybeans include the Forest-Steppe of Ukraine (about 60 % of all soybean acreage is concentrated here), Polissia, (here its acreage comprises 24 %), and the Steppe (16 % of acreage) [2].

With further aridity of the Ukrainian climate, an increase in the sum of positive and active temperatures during the growing season, a decrease in precipitation, soil and air drought, and the role of soybean varieties, as well as maintaining their stable productivity and improving yield, is emphasized.

When it comes to the selection of soybean varieties, it is necessary to assess their productivity, duration of the growing season, resistance to adverse environmental conditions, suitability for mechanized harvesting and other factors. Since the number of soybean varieties that have officially entered the State Register of Plant Varieties of Ukraine Suitable for Cultivation in 2021 is high (and a significant part of them is of foreign selection), the researchers' task is to evaluate not only their productivity but also agricultural properties, sustainability and adaptability.

Review of recent research and publications. It is important for modern soybean varieties to have high adaptive properties. Another significant component of the variety characteristics is the quality of the harvest, environmental resistance, and the economic feasibility of its cultivation [3].

When it comes to the selection of soybean varieties, it is necessary to consider the natural and climatic conditions of the area where it will be grown, the chemical composition of seeds, and the height of the lower beans. Soybeans should have at least 3 seeds and 10–11 productive nodes on the stem. A plant has to be small and full-grown. A ripe and ready-to-harvest variety should neither crack nor shed [4].

However, a number of objective circumstances are a hindrance to increasing the productivity of soybeans at a rapid pace. One of them is the inconsistency of the varietal policy with the available assortment of soybean varieties of different maturity groups suitable for cultivation in the Ukrainian soil and climatic conditions.

When it comes to the selection of soybean varieties, the intensity of growth at the initial stages is one of the important properties to consider. Varieties with high levels of initial growth quickly cover the soil surface and cause less evaporation of moisture. Another essential characteristic of soybean varieties is resistance to drought, which is particularly important for varieties that are recommended for cultivation in the Steppe of Ukraine. Resistance to drought enables plants to effectively store and use small moisture reserves as there is little evaporation and the soil is densely covered by the leaves slowing down the reaction to moisture deficit [5, 15–22].

There are five maturity groups of soybean varieties suitable for cultivation in Ukraine the ripening of which is guaranteed. Mid-early varieties provide the highest seed yield – it reaches 4 t/ha and more. This means that mid-early soybean varieties should dominate in the Forest-Steppe of Ukraine and its Polissia region, taking up to 55–65 % of the sowing areas [6, 10–14].

However, mid-early soybean varieties are so numerous in the State Register of Plant Varieties of Ukraine Suitable for Cultivation in 2021 that this list is of little help, to say the least – it is often an obstacle when it comes to selection.

Aim of the study. Therefore, the goal of our research is to analyse the varietal composition of mid-early soybean varieties with regard to such characteristics as plant height and attachment of lower beans, resistance to lodging, shedding, drought and disease, seed yield, protein and fat content.

Materials and methods. The study is based on the State Register of Plant Varieties of Ukraine Suitable for Cultivation in 2021 [7]. All mid-early soybean varieties recommended for cultivation in Ukraine were evaluated with regard to certain indicators. They include the growing season, height of lower beans attachment, plant height, resistance to lodging, shedding, drought and disease, seed yield, protein and fat content.

Specified indicators were determined with the help of the Methodology for the examination of plant varieties of the cereal, grain and legumes. Their suitability for cultivation in Ukraine was assessed [8]. We were

particularly interested in the plants' resistance to lodging, shedding, drought and disease and conducted a visual evaluation of the varieties on a nine-point scale using the following gradation: 9 points – the variety is excellent; 7 points – the variety is good; 5 points – the variety is satisfactory; 3 points – the variety is bad; 1 point – the variety is very bad.

We assessed the resistance of soybean varieties to the following diseases: downy mildew (*Peronospora manshurica* Sydow), ascochitosis (*Ascochytasojaecola* Abramov), bacteriosis (*Pseudomonas, Xanthomonas, Erwinia*), septoriosis (*Septoria glycines* T. Hemmi), and fusarium (*Fusarium* Link.).

Experiments with soybean varieties were conducted on plots of 10–25 m^2; the state variety test was repeated four times.

Results and discussion. There are five groups of soybean varieties suitable for cultivation in Ukraine based on the speed of ripening – ultra quick ripening, early ripening, mid-early ripening, mid-ripening and mid-late ripening. Mid-early varieties (their growing season comprises 106–125 days) are the most numerous group according to the State Register of Plant Varieties of Ukraine Suitable for Cultivation in 2021 with a total of 160 items.

The average plant height of mid-early soybean varieties is 82 cm. Oksana variety is the highest one – 158 cm, *Saska* comes next – 135 cm, Yuvileyna, Podyaka, Vityaz *50* are 115 cm each, Valiuta, Merkur are 110 cm each. Viola variety is the lowest one – 63 cm, RGT Sphinx is 64 cm, Krynytsia – 65 cm, Chernivetska 9 and Regina are 66 cm each, Astor and Tivaz are 67 cm each, Sloboda, Akardiya, ES Professor – 68 cm each, Vyshyvanka, Fantasia, ES Luxor – 69 cm each (Table 1).

1. Indicators of Adaptability of Mid-Early Soybean Varieties

The average height of lower bean attachment and its distance from the soil surface in soybean varieties of this maturity group comprises 13 cm. Varieties with the highest attachment of the lower beans include Georgina – 23 cm, Syaivo, OAC Morden – 19 cm each, OAC Prescott, Millennium, Saska, Vezha – 17 cm each. Varieties with the lowest attachment of lower beans include, Solena, RGT Sphinxa – 9 cm each, Sprint, Titan, ES Bachelor, Siberia, Akardia, Tivaz, Bettina, Vitalina, Elina, Mozart, Mariem, Viola, Alexa, Soprana – 10 cm each.

We established an average positive correlation between the height of plants of mid-early soybean varieties and the height of lower beans attachment (r = 0.383). There is a direct dependence between the two.

As for the average score of resistance to lodging in mid-early soybean varieties, it comprises 8.2 – 49 varieties have the highest resistance to lodging with a score of 9 points. Such varieties as Fantasia (4 points), Artemis, Aurora, Pivdenna Zorya (6 points) have the lowest resistance to lodging.

The average resistance to the shedding of the soybean varieties under consideration is 8.1 points – 34 soybean varieties have the highest resistance with a score of 9 points. Alexa variety has the lowest resistance to shedding with a score of 5 points, Artemis and Aris got 6 points, and another 12 varieties received 7 points.

The average score of drought resistance of mid-early soybean varieties is 8–21 varieties have the highest score of 9 points. OAC Acclaim has the lowest score for drought resistance – 5 points, Ophelia and Fantasia received 6 points, and another 16 varieties got 7 points (Table 2).

2. Indicators of Agroecological Stability, Yield and Seed Quality of Mid-Early Soybean Varieties

We established an average positive correlation (r = 0.334) between the score of drought resistance and resistance to the lodging of mid-early soybean varieties. The higher the drought resistance score of soybean varieties, the more resistant they are to lodging.

The average disease resistance score of the soybean varieties under consideration is 8.6 – 97 soybean varieties have the highest disease resistance score, which is 9 points. Artemis has the lowest disease resistance score – 6 points, Asuka, and Vityaz 50 received 7 points each.

The average seed yield of the soybean varieties under consideration is 27.2 t/ha. The highest productivity is characteristic of such varieties as Podyaka – 37.0 t/ha, Ezra, Stine 07G22 – 36.5 c/ha each, Saska, Syaivo – 35.0 c/ha each, Cypress – 34.6 c/ha, Malvina – 34.5 c/ha, SVH15T1S1 – 34.4 c/ha, ES Composer, Turizas, Elina – 33.3 c/ha each. Valiuta has the lowest seed yield – 17.5 c/ha, Kyivska 98 – 17.8 c/ha, Abelina – 18.0 c/ha, Sprint – 18.5 c/ha, Oksana – 18.8 c/ha.

The average protein content in the seeds of mid-early soybean varieties is 40.2%. RGT Sforza variety has the highest protein content – 45.5%, DSh401 –45.2%, ES Bachelor – 44.7%, Taurus, NS Diyana, DSh863 – 44.1% each, Lenka – 43.0%. At the same time, the seeds of the following soybean varieties have the lowest protein content: Valiuta – 34.9%, Ophelia – 35.6%, Kyivska 98 – 35.7%, Charm – 36.0%, KyVin, Sprint – 36, 2%.

The average fat content in the seeds of mid-early soybean varieties is 21.3%. Charm has the highest content of fat – 24.5%, Valiuta – 23.6%, Brown – 23.4%, Sprint and Everest – 23.2% each, and SG Anzer – 23.1%. Femida has the lowest fat content – 18.0%, Smolianka – 18.1% and ES Bachelor – 18.6%.

We established an average negative correlation between the content of fat and protein in the seeds of mid-early soybean varieties (r= – 0.330). That is, the higher the fat content in the seeds of mid-early soybean varieties, the lower their protein content is.

Conclusions and future prospects. According to the State Register of Plant Varieties of Ukraine Suitable for Cultivation in 2021, such mid-early soybean varieties as Podyaka, Ezra, Stine 07G22, Saska, Syavo, Cypress, Malvina, SVH15T1C1, ES Composer, Turizas, and Elina have the highest seed yield. RGT Sforza, DSh401, ES Bachelor, Taurus, NS Diyana, DSh863, and Lenka are varieties with the highest protein content. As for fat, these are Charm, Valiuta, Brown, Sprint, Everest, and SG Anzer. A significant part of mid-early soybean varieties is highly resistant to drought, diseases, lodging and shedding of seeds and gained the highest scores.

Further research in the area should be aimed at the comparison of productivity, adaptability and sustainability of mid-early soybean varieties with other maturity groups.

Table 1

Variety	Growing season, days	Height of lower beans attachment, cm	Plant height, cm	Resistance to lodging, score	Resistance to shedding, score
Ophelia	125	16	85	8	8
Gallek	114	11	77	9	9
NS Diyana	118	14	84	8	8
Orpheus	119	14	77	7	8
Brunensis	114	11	77	9	9
SVH15T1S1	117	11	78	8	8
Taurus	115	14	89	8	8
Mariem	115	10	71	9	8
Stine 06H02	119	13	79	8	8
Valiuta	115	13	110	8	8
Amadea	109	14	77	8	8
Albenga	110	11	74	9	8
Monarkh	100	16	82	9	9
Femida	120	15	80	8	8
Zolotysta	110	15	95	8	8
Yuvileina	120	18	115	8	8
Svyatkova	107	11	75	9	9
Omega Vinnytska	118	15	96	9	9
KyVin	112	13	80	8	8
Monada	121	13	100	8	8
Smolianka	118	14	75	8	8
Charm	116	13	103	8	8
Danaya	125	14	102	9	9
Georgina	117	23	75	7	7
Syaivo	112	19	90	7	7
Vezha	112	17	75	8	8
Khutoryanochka	109	13	75	8	8
Suzirya	112	14	91	8	8
Merkur	112	14	110	8	8
Knyazhna	108	14	75	8	7
Podyaka	116	13	115	8	8
Malvina	112	13	75	9	9
Cardiff	115	14	88	9	8
Romashka	122	19	90	8	8
Zolushka	107	12	96	8	9
Luna	120	13	75	8	8
Kofu	112	12	90	8	8
Saska	120	17	135	8	8
Sigaliya	122	16	80	8	8
Sinara	125	15	80	9	9
Opalin	116	15	82	9	8
Cassidi	115	13	80	9	9
Kyoto	124	13	73	8	8
Krynytsia	119	13	65	9	9
Diadema Podilia	110	13	75	7	8
Sofia	117	12	85	8	8
Cordoba	115	13	85	8	8
Millenium	107	17	90	8	8
DKh 618	119	14	76	8	8
DKh 530	120	15	87	8	9
OAC Calypso	123	15	90	8	8

Variety	Growing season, days	Height of lower beans attachment, cm	Plant height, cm	Resistance to lodging, score	Resistance to shedding, score
Arisa	120	13	95	9	6
Asuka	115	12	72	8	7
Amadeus	115	12	73	8	8
Nordica	115	12	80	8	8
Abelina	115	13	80	8	8
Obelix	121	12	77	9	9
Azymut	120	15	80	8	8
ES Tenor	115	12	77	9	9
Pereyaslavka	115	14	80	8	9
Marysia	123	14	78	8	8
Yasochka	115	15	86	9	9
Vyshyvanka	110	12	69	8	8
Corona	124	13	84	8	8
RGT Speda	115	16	83	9	9
Viola	115	10	63	9	8
Sculptor	115	13	85	9	9
DSh401	117	13	73	8	8
DSh863	117	14	73	8	8
Emperor	125	13	80	8	8
Samorodok	106	13	74	8	8
OAC Prescott	120	17	90	8	8
ОАЦ Morden	112	19	87	8	8
OAC Strive	120	14	92	8	8
NS Diyana	118	14	84	8	8
Alexa	108	10	74	8	5
Everest	113	13	73	8	8
RGT Svila	122	13	87	8	8
RGT Sforza	119	13	82	9	8
RGT Stumpa	117	14	73	8	8
ES Commandor	110	14	74	8	9
SG Kea	118	13	76	8	8
SG Anzer	110	14	74	8	8
Eurydice	122	13	79	7	8
Sylvia PZO	116	14	83	9	8
Lenka	118	12	82	8	8
Volta	117	11	85	9	9
SB 142	115	13	72	8	8
SB 143	120	13	71	8	8
Soprana	114	10	70	8	8
RGT Siroca	112	11	75	8	8
ES Adviser	117	13	86	8	8
Sloboda	106	14	68	7	8
Aurora	120	14	89	6	8
Pivdenna Zorya	123	13	94	6	8
Graf	114	14	92	7	8
Brown	122	16	93	7	8
Regina	110	11	66	9	8
Stine 06H02	119	13	79	8	8
Stine 14H02	125	13	82	8	8
Stine 09I36	123	16	85	8	8
Stine 07G22	119	12	79	8	8
Mozart	111	10	77	9	8

Variety	Growing season, days	Height of lower beans attachment, cm	Plant height, cm	Resistance to lodging, score	Resistance to shedding, score
Astor	111	12	67	8	8
Neptune	114	12	72	8	8
Tala	117	13	84	8	8
Cypress	117	15	79	8	8
Elina	106	10	80	8	8
Zeus	119	14	84	7	8
Vitalina	115	10	84	7	8
Karmelita	117	15	86	7	8
Bettina	109	10	70	9	8
Aurelina	107	12	75	8	8
Altona	111	12	76	8	8
Sireliya	106	11	72	9	9
Tivaz	107	10	67	9	8
Turizas	117	15	78	8	8
Inguz	116	12	75	8	8
Jade	114	11	82	8	8
Dara	115	14	81	8	8
Angelika	113	12	81	9	9
Atakama	114	12	72	9	9
Akardiya	115	10	68	7	9
Vista	107	11	71	9	8
Aziura	114	11	78	8	8
Siberia	106	10	70	9	7
Ezra	118	12	83	8	8
DH4202	114	12	75	7	9
DH 4173	116	11	78	9	9
Churayivna	109	12	82	9	8
Solena	110	9	73	9	8
RGT Sphinxa	108	9	64	9	9
ES Tribor	118	13	72	8	9
ES Professor	111	11	68	9	7
ES Luxor	111	10	69	9	7
ES Compositor	109	14	84	9	9
ES Chancellor	110	13	82	9	8
ES Bachelor	112	10	73	9	7
ES Decor	106	12	77	9	8
Serenade	114	13	79	7	7
Titan	112	10	70	9	9
Yakari	110	13	72	9	8
Fantasia	106	14	69	4	7
OAC Acclaim	114	12	73	9	9
Vutyaz 50	119	15	115	8	7
Izumrudna	120	16	75	8	8
Deimos	122	15	85	8	8
Chernivetska 9	114	11	66	8	8
Artemis	111	12	84	6	6
Oksana	121	13	158	8	8
Kyivska 98	113	12	90	8	8
Sprint	116	10	83	8	7
PR 9368 B07	125	11	75	9	9
DM 503	119	13	81	8	9
Buga	123	16	98	8	8

Table 2

Variety	Resistance to drought, score	Resistance to diseases, score	Seed yield, c/ha	Protein content in seed, %	Fat content in seed, %
Ophelia	6	8	20.1	35.6	21.6
Gallek	9	9	26.3	39.3	20.5
NS Diyana	8	9	25.0	44.1	20.7
Orpheus	8	9	23.6	41.2	22.3
Brunensis	9	9	26.3	39.3	20.5
SVH15T1S1	8	8	34.4	38.1	22.3
Taurus	8	9	28.3	44.1	21.1
Mariem	8	8	31.9	40.3	21.7
Stine 06H02	8	9	31.4	42.0	19.8
Valiuta	8	8	17.5	34.9	23.6
Amadea	8	9	27.7	40.4	22.9
Albenga	8	8	32.6	41.1	20.8
Monarkh	9	9	22.1	39.0	21.7
Femida	8	8	30.0	37.5	18.0
Zolotysta	7	8	30.0	39.7	21.0
Yuvileina	7	8	31.0	39.0	21.5
Svyatkova	8	8	25.0	38.5	20.5
Omega Vinnytska	8	9	21.8	36.8	22.9
KyVin	8	8	21.1	36.2	23.0
Monada	8	9	22.0	38.5	18.8
Smolianka	8	9	26.0	36.6	18.1
Charm	8	8	20.0	36.0	24.5
Danaya	8	9	27.9	38.0	21.6
Georgina	8	9	31.0	41.5	20.4
Syaivo	8	8	35.0	38.5	21.5
Vezha	8	9	28.0	39.3	19.6
Khutoryanochka	8	9	35.0	39.0	20.5
Suzirya	8	8	35.0	42.5	20.5
Merkur	8	9	28.0	39.5	20.0
Knyazhna	7	9	26.0	38.5	20.0
Podyaka	8	8	37.0	39.5	22.5
Malvina	8	8	34.5	39.5	21.5
Cardiff	8	9	23.4	42.7	20.0
Romashka	7	8	28.5	40.8	20.9
Zolushka	8	9	19.7	39.8	21.3
Luna	8	9	25.0	40.0	20.0
Kofu	8	8	25.0	41.5	22.0
Saska	8	8	35.0	41.0	20.0
Sigaliya	8	8	22.0	40.5	21.0
Sinara	8	9	24.8	41.0	21.0
Opalin	8	9	22.6	37.8	21.5
Cassidi	8	9	25.2	40.0	20.0
Kyoto	8	8	30.0	43.0	21.0
Krynytsia	8	9	23.3	39.4	20.0
Diadema Podilia	8	9	29.0	38.7	18.8
Sofia	8	9	20.0	39.5	21.0
Cordoba	8	8	25.0	39.0	20.0
Millenium	8	9	25.0	41.0	20.0
DKh 618	9	8	25.0	41.5	19.8
DKh 530	9	8	22.3	41.5	19.8
OAC Calypso	9	9	22.7	39.4	21.2
Arisa	8	8	22.0	40.0	22.0
Asuka	9	7	25.4	42.0	20.5
Amadeus	8	9	21.7	42.5	19.0
Nordica	8	9	25.0	40.0	20.0

Variety	Resistance to drought, score	Resistance to diseases, score	Seed yield, c/ha	Protein content in seed, %	Fat content in seed, %
Abelina	8	8	18.0	39.5	20.0
Obelix	9	9	25.1	40.0	22.4
Azymut	8	9	23.8	39.5	21.7
ES Tenor	9	9	23.7	39.3	22.3
Pereyaslavka	9	9	22.0	40.1	22.2
Marysia	8	9	24.2	41.1	21.0
Yasochka	9	9	22.4	41.6	21.2
Vyshyvanka	8	9	24.9	39.2	21.8
Corona	9	8	24.0	40.1	21.7
RGT Speda	9	9	20.9	42.8	21.8
Viola	8	9	20.6	41.8	22.3
Sculptor	8	9	21.0	41.9	21.9
DSh401	8	9	22.2	45.2	20.6
DSh863	8	9	23.0	44.1	21.0
Emperor	8	9	23.4	42.5	21.5
Samorodok	8	9	22.7	41.0	22.0
OAC Prescott	8	9	24.6	40.0	22.3
ОАЦ Morden	8	9	28.6	40.4	22.5
OAC Strive	8	9	25.5	42.2	22.1
NS Diyana	8	9	25.0	44.1	20.7
Alexa	8	9	28.4	41.4	21.3
Everest	8	9	25.4	39.7	23.2
RGT Svila	8	9	23.5	43.5	21.3
RGT Sforza	8	9	23.2	45.5	20.2
RGT Stumpa	8	9	26.2	40.0	22.3
ES Commandor	8	9	26.6	42.0	21.2
SG Kea	8	9	26.8	41.0	22.1
SG Anzer	8	9	25.5	40.0	23.1
Eurydice	8	9	24.0	42.0	21.6
Sylvia PZO	8	9	29.3	38.6	22.6
Lenka	8	9	27.5	43.0	22.0
Volta	9	8	25.1	40.5	21.7
SB 142	8	9	30.2	42.5	20.4
SB 143	9	8	27.6	42.5	20.2
Soprana	9	8	29.3	39.4	22.4
RGT Siroca	9	9	33.4	40.2	22.4
ES Adviser	8	9	31.5	40.1	22.8
Sloboda	8	9	24.7	40.8	20.3
Aurora	8	9	26.6	40.7	21.3
Pivdenna Zorya	7	9	27.3	40.6	21.3
Graf	8	9	32.1	39.9	21.9
Brown	8	9	29.8	37.4	23.4
Regina	8	9	33.4	41.2	21.8
Stine 06H02	8	9	31.4	42.0	19.8
Stine 14H02	8	9	32.6	42.3	20.2
Stine 09I36	8	9	31.0	38.8	22.0
Stine 07G22	8	9	36.5	40.1	20.6
Mozart	8	9	30.4	42.8	20.0
Astor	7	8	30.3	40.6	22.3
Neptune	8	8	32.8	39.9	22.0
Tala	8	9	30.4	39.3	22.0
Cypress	8	9	34.6	40.6	21.0
Elina	8	8	33.3	40.5	21.9
Zeus	8	8	30.1	40.1	22.1
Vitalina	8	8	30.3	38.3	22.8
Karmelita	7	8	30.4	41.0	21.3

Variety	Resistance to drought, score	Resistance to diseases, score	Seed yield, c/ha	Protein content in seed, %	Fat content in seed, %
Bettina	8	9	32.2	41.5	21.6
Aurelina	8	8	31.1	41.9	21.4
Altona	8	8	32.9	39.1	22.2
Sireliya	8	8	31.0	39.0	22.7
Tivaz	8	8	29.1	40.8	21.9
Turizas	8	8	33.3	38.5	21.5
Inguz	8	8	31.9	38.3	21.6
Jade	8	8	33.1	36.8	22.9
Dara	7	8	31.6	37.9	22.4
Angelika	9	9	30.0	41.0	20.9
Atakama	8	9	32.3	40.3	21.4
Akardiya	8	8	29.7	38.3	21.6
Vista	8	8	30.5	39.8	21.5
Aziura	8	8	29.4	41.8	21.3
Siberia	7	8	24.5	39.7	20.8
Ezra	8	8	36.5	37.2	22.2
DH4202	8	9	30.8	39.1	22.0
DH 4173	8	9	29.7	39.4	21.2
Churayivna	7	9	26.4	40.0	21.3
Solena	8	9	30.1	41.0	21.1
RGT Sphinxa	7	9	28.7	42.1	20.7
ES Tribor	7	9	29.1	41.3	20.6
ES Professor	7	8	29.1	42.3	21.0
ES Luxor	8	8	26.8	40.9	21.4
ES Compositor	8	9	33.3	40.1	22.0
ES Chancellor	8	9	28.8	39.9	21.3
ES Bachelor	7	8	26.8	44.7	18.6
ES Decor	8	9	28.4	41.9	21.2
Serenade	6	9	24.9	41.7	18.9
Titan	8	9	29.5	42.3	20.9
Yakari	8	8	32.7	40.9	20.6
Fantasia	6	8	23.7	40.6	19.9
OAC Acclaim	5	9	29.3	40.1	21.3
Vutyaz 50	8	7	25.0	40.0	22.5
Izumrudna	7	8	26.0	41.0	21.0
Deimos	8	8	22.0	39.2	22.2
Chernivetska 9	8	8	30.0	36.3	21.5
Artemis	8	6	24.7	39.7	22.2
Oksana	8	8	18.8	37.6	21.4
Kyivska 98	8	8	17.8	35.7	21.9
Sprint	8	8	18.5	36.2	23.2
PR 9368 B07	9	9	26.6	40.0	21.5
DM 503	8	9	31.9	39.4	22.4
Buga	7	9	20.9	39.6	20.5

BIBLIOGRAPHY:

1. Кренців Я., Медведєва Л., Гайденко О. Сорти сої: обираємо кращий. *Агробізнес сьогодні.* URL: http://agro-business.com.ua/ahrarni-kultury/item/19517-sorty-soi-obyraiemo-krashchyi.html (дата звернення 21.12.2021).
2. Технологія вирощування сої на прикладі господарств різних регіонів. *Супераграном.* URL: https://superagronom.com/articles/447-tehnnologiya-viroschuvannya-soyi-na-prikladi-gospodarstv-riznih-regioniv (дата звернення 21.12.2021).
3. Нетіс В.І. Формування елементів продуктивності сої за різних заходів вирощування. *Таврійський науковий вісник*. Херсон. 2018. Вип. 99. С. 100-107.
4. Шелкопляс Т. Сто бобів для сої – не межа. *Агропрофі*. URL: http://www.agroprofi.com.ua/statti/1781-100-bobiv-dlja-soyi-ne-mezha (дата звернення 21.12.2021).
5. Кифорук В. Вибір сортів сої для вирощування в умовах 2020 року. URL: https://bionorma.ua/media/articles/vybir-sortiv-soyi-dlya-vyroshhuvannya-v-umovah-2020-roku/ (дата звернення 21.12.2021).

6. Демидов О.А., Петриченко В.Ф., Січкар В.І., Тимченко В.Н. Соєві амбіції України. *Аграрний тиждень. Україна.* URL: https://a7d.com.ua/plants/1074-soyevi-ambiciyi-ukrayini.html (дата звернення 21.12.2021).
7. Державний реєстр сортів рослин, придатних для поширення в Україні на 2021 рік. Київ. 2021. 537 с.
8. Методика проведення експертизи сортів рослин групи зернових, круп'яних та зернобобових на придатність до поширення в Україні. Київ. 2016. 81 с. URL: https://sops.gov.ua/uploads/page/5a5f4147d3595.pdf (дата звернення 21.12.2021).
9. Didur I., Bakhmat M., Shynchyk O., Pantsyreva H., Telekalo N., Tkachuk O. Substantiation of agroecological factors on soybean agrophytocenoses by analysis of variance of the Right-Bank Forest-Steppe in Ukraine. *Ukrainian Journal of Ecology*. 2020. № 10 (5). P. 54-61.
10. Honcharuk, I. Use of wastes of the livestock industry as a possibility for increasing the efficiency of aic and replenishing the energy balance. *Visegrad Journal on Bioeconomy and Sustainable Development*. 2020. Vol. 9. № 1. P. 9–14.
11. Панцирева Г. В. Дослідження сортових ресурсів люпину білого (Lupinus albus L.) в Україні. Вінниця. 2016. Вип. 4. С. 88-93.
12. Mazur V.A., Myalkovsky R.O., Pantsyreva H.V., Didur I.M., Mazur K.V., Alekseev O.O. Photosynthetic productivity of potato plants depending on the location of rows placement in agrophytocenosis. *Eco. Env. & Cons*. 2020. Vol. 26 (2). P. 46-55.
13. Puyu V., Bakhmat M., Pantsyreva H., Khmelianchyshyn Y., Stepanchenko V., Bakhmat O. Social-and-Ecological Aspects of Forage Production Reform in Ukraine in the Early 21st Century. *European Journal of Sustainable Development.* 2021. Vol. 10 (1). P. 221-228
14. Didur I., Bakhmat M., Chynchyk O., Pantsyreva H., Telekalo N., Tkachuk O. Substantiation of agroecological factors on soybean agrophytocenoses by analysis of variance of the Right-Bank Forest-Steppe in Ukraine. *Ukrainian Journal of Ecology.* 2020. Vol. 10(5). P. 54-61.
15. Bandura V., Mazur V., Yaroshenko L., Rubanenko O. Research on sunflower seeds drying process in a monolayer tray vibration dryer based on infrared radiation. *INMATEN – Agricultural Engineering*. 2019. Vol. 57. №1. P. 233-242.
16. Мазур В.А., Дідур І.М., Панцирева Г.В. Обґрунтування адаптивної сортової технології вирощування зернобобових культур в правобережному Лісостепу України. *Сільське господарство та лісництво*. 2020. Вип. 18. С. 5-16.
17. Панцирева Г.В. Сортові ресурси зернобобових культур в Україні: сучасний стан та перспективи використання. *Сільське господарство та лісництво*. 2020. Вип. 17. С. 30-41.
18. Панцирева Г.В. Особливості водоспоживання рослин люпину білого в умовах правобережного Лісостепу України. *Вісник ЛНАУ*. 2020. Вип. 24. С. 72-78.
19. Kaletnik G. Honcharuk, I. 2013. Innovatsiine zabezpechennia rozvytku biopalyvnoi haluzi: svitovyi ta vitchyznianyi dosvid [Innovative support for the development of the biofuel industry: world and national experience]. *In Biznes Inform [Business Inform]*. 2013. №. 9. P. 155–160.
20. Kaletnik G., Honcharuk I., Okhota Yu. The Waste-Free Production Development for the Energy Autonomy Formation of Ukrainian Agricultural Enterprises. *Journal of Environmental Management and Tourism*. 2020. Vol. XI. Summer. № 3 (43). P. 513-522. DOI:10.14505/jemt.v11.3(43).02
21. Kaletnik G., Honcharuk I., Yemchyk T., Okhota Yu. The World Experience in the Regulation of the Land Circulation. *European Journal of Sustainable Development.* 2020. № 9 (2). P. 557-568.

REFERENCES:

1. Krentsiv, Ya., Medvedieva, L., Haidenko, O. Sorty soi: obyraiemo krashchyi [Soybean Varieties: How to Choose the Best Ones]. Agricultural Business Today. URL: http://agro-business.com.ua/ahrarni-kultury/item/19517-sorty-soi-obyraiemo-krashchyi.html (date of application December 21, 2021). [in Ukrainian].
2. Tekhnolohiia vyroshchuvannia soi na prykladi hospodarstv riznykh rehioniv [Technology of Soybeans Cultivation on the Example of Farms Located in Different Regions]. Superagriculturist. URL: https://superagronom.com/articles/447-tehnnologiya-viroschuvannya-soyi-na-prikladi-gospodarstv-riznih-regioniv (date of application December 21, 2021). [in Ukrainian].
3. Netis, V.I. (2018). Formuvannia elementiv produktyvnosti soi za riznykh zakhodiv vyroshchuvannia [Formation of Soybean Productivity Elements under Different Growing Strategies]. Taurian Scientific Bulletin. Kherson. №. 99. Pp. 100–107. [in Ukrainian].
4. Shelkoplias, T. Sto bobiv dlia soi – ne mezha. [One Hundred Beans for Soy is Hardly the Limit]. *Agroprofessionals.* URL: http://www.agroprofi.com.ua/statti/1781-100-bobiv-dlja-soyi-ne-mezha (date of application December 21, 2021). [in Ukrainian].
5. Kyforuk, V. Vybir sortiv soi dlia vyroshchuvannia v umovakh 2020 roku [Selection of Soybean Varieties for Cultivation in 2020]. URL: https://bionorma.ua/media/articles/vybir-sortiv-soyi-dlya-vyroshhuvannya-v-umovah-2020-roku/ (date of application December 21, 2021). [in Ukrainian].
6. Demydov, O.A., Petrychenko, V.F., Sichkar, V.I., Tymchenko, V.N. Soievi ambitsii Ukrainy [Soy Ambitions of Ukraine]. Agrarian Week. Ukraine. URL: https://a7d.com.ua/plants/1074-soyevi-ambiciyi-ukrayini.html (date of application December 21, 2021). [in Ukrainian].
7. Derzhavnyi reiestr sortiv roslyn, prydatnykh dlia poshyrennia v Ukraini na 2021 rik [State Register of Plant Varieties of Ukraine Suitable for Cultivation in 2021]. Kyiv. 2021. P. 537. [in Ukrainian].
8. Metodyka provedennia ekspertyzy sortiv roslyn hrupy zernovykh, krupianykh ta zernobobovykh na prydatnist do poshyrennia v Ukraini [Methodology for Assessing Plant Varieties of Cereal, Grain and Legumes and the Evaluation of their Suitability for Cultivation in Ukraine]. Kyiv. 2016. P. 81. URL: https://sops.gov.ua/uploads/page/5a5f4147d3595.pdf (date of application December 21, 2021). [in Ukrainian].
9. Didur, I., Bakhmat, M., Chynchyk, O., Pantsyreva, H., Telekalo, N., Tkachuk, O. (2020). Substantiation of Agroecological Factors on Soybean Agrophytocenosis by Analysis of Variance of the Right-Bank Forest-Steppe in Ukraine. Ukrainian Journal of Ecology. 10 (5). Pp. 54–61.
10. Honcharuk, I. (2020). Use of Wastes of the Livestock Industry as a Possibility for Increasing the Efficiency

of AIC and Replenishing the Energy Balance. Visegrad Journal on Bioeconomy and Sustainable Development. Vol. 9. №. 1. Pp. 9–14.
11. Pantsyreva, H. V. (2016). Doslidzhennia sortovykh resursiv liupynu biloho (Lupinus albus L.) v Ukraini [Study of Varietal Resources of White Lupine (*Lupinus albus L.*) in Ukraine]. Vinnytsia. №. 4. Pp. 88-93. [in Ukrainian].
12. Mazur,V.A.,Myalkovsky,R.O.,Pantsyreva,H.V.,Didur,I.M., Mazur, K. V., Alekseev, O. O. (2020). Photosynthetic Productivity of Potato Plants Depending on the Location of Rows Placement in Agrophytocenosis. Eco. Env. & Cons. Vol. 26 (2). Pp. 46–55.
13. Puyu, V., Bakhmat, M., Pantsyreva, H., Khmelianchyshyn, Y., Stepanchenko, V., Bakhmat, O. (2021). Social and Ecological Aspects of Forage Production Reform in Ukraine in the Early 21st Century. European Journal of Sustainable Development. Vol. 10 (1). Pp. 221–228
14. Didur, I. M., Pantsyreva, H. V., Telekalo, N. V. (2020). Agroecological Rationale of Technological Methods of Growing Legumes. Scientific Heritage. Vol. 52. Pp. 3–7.
15. Bandura, V., Mazur, V., Yaroshenko, L., Rubanenko, O. (2019). Research on Sunflower Seeds Drying Process in a Monolayer Tray Vibration Dryer Based on Infrared Radiation. INMATEN – Agricultural Engineering. Vol. 57. №.1. Pp. 233–242.
16. Mazur, V.A., Didur, I.M., Pantsyreva, H.V. (2020). Obgruntuvannia adaptyvnoi sortovoi tekhnolohii vyroshchuvannia zernobobovykh kultur v pravoberezhnomu Lisostepu Ukrainy [Substantiation of the Adaptive Varietal Technology of Growing Legumes in the Right-Bank Forest-Steppe of Ukraine]. Agriculture and Forestry. №. 18. Pp. 5–16. [in Ukrainian].
17. Pantsyreva, H.V. (2020). Sortovi resursy zernobobovykh kultur v Ukraini: suchasnyi stan ta perspektyvy vykorystannia [Varietal resources of leguminous crops in Ukraine: current state and prospects of use]. Agriculture and Forestry. №.17. Pp. 30–41. [in Ukrainian].
18. Pantsyreva, H.V. (2020). Osoblyvosti vodospozhyvannia roslyn liupynu biloho v umovakh pravoberezhnoho Lisostepu Ukrainy [Characteristics of Water Consumption of White Lupine in the Right-Bank Forest-Steppe of Ukraine]. Bulletin of Lviv National Agrarian University. № 24. Pp. 72–78. [in Ukrainian].
19. Kaletnik, G. Honcharuk, I. (2013). Innovatsiine zabezpechennia rozvytku biopalyvnoi haluzi: svitovyi ta vitchyznianyi dosvid. [Innovative Support for the Development of the Biofuel Industry: World and National Experience]. Business Inform. №. 9. Pp. 155–160. [in Ukrainian].
20. Kaletnik, G., Honcharuk, I., Okhota, Yu. (2020). Waste-Free Production Development for the Energy Autonomy Formation of Ukrainian Agricultural Enterprises. Journal of Environmental Management and Tourism. Vol. XI. Summer. 3 (43). Pp. 513-522. DOI:10.14505/jemt.v11.3(43).02.
21. Kaletnik, G., Honcharuk, I., Yemchyk, T., Okhota, Yu. (2020). World Experience in the Regulation of the Land Circulation. European Journal of Sustainable Development. № 9 (2). Pp. 557–568.

Tkachuk O.P., Didur I.M., Mazur O.V. Adaptability, sustainability and productivity of mid-early soybean varieties

There is a large number of mid-early high-yielding soybean varieties suitable for cultivation in Ukraine. Therefore, the selection of the most efficient, high-yielding, adaptable and sustainable ones is required. The aim of the study is to analyse mid-early soybean varieties regarding the height of plants, the attachment of lower beans, their resistance to lodging, shedding, drought and various diseases, seed yield, protein and fat content. The research was conducted on the basis of the State Register of Plant Varieties of Ukraine Suitable for Cultivation in 2021.

There are five groups of soybean varieties suitable for cultivation in Ukraine based on the speed of ripening – ultra quick ripening, early ripening, mid-early ripening, mid-ripening and mid-late ripening. Mid-early varieties (their growing season comprises 106–125 days) are the most numerous group according to the State Register of Plant Varieties of Ukraine Suitable for Cultivation in 2021 with a total of 160 items.

According to the State Register of Plant Varieties of Ukraine Suitable for Cultivation in 2021, such varieties as Podyaka, Ezra, Stine 07G22, Saska, Syaivo, Cypress, Malvina, SVH15T1S1, ES Compositor, Turizas, and Elina have the highest seed yield among all mid-early soybean varieties. RGT Sforza, DSh401, ES Bachelor, Taurus, NS Diyana, DSh863, Lenka contain the highest amount of protein, whereas Charm, Valiuta, Brown, Sprint, Everest, SG Anzer have the highest level of fat. A significant part of mid-early soybean varieties shows a high rate of resistance to drought, diseases, lodging and shedding and received 8 points on our scale, which means that they are suitable both for mechanical harvesting and sustainable vegetation.

Key words: soybeans, varieties, productivity, adaptability, sustainability.

Ткачук О.П., Дідур І.М., Мазур О.В. Адаптивність, стійкість і продуктивність середньоранньостиглих сортів сої

Велике різноманіття середньо ранньостиглих сортів сої, що придатні до вирощування в Україні та належать до найбільш урожайної групи, вимагає вибору оптимальних за параметрами урожайності, технологічності та екологічності. Метою досліджень було проаналізувати сортовий склад середньо ранньостиглих сортів сої за показниками висоти рослин та прикріплення нижніх бобів, стійкості до вилягання, осипання, посухостійкості, стійкості до хвороб, урожайністю насіння та вмістом у ньому білка і жиру. Дослідження проводили опрацюванням матеріалів Державного реєстру сортів рослин України, придатних для вирощування у 2021 році.

Із п'яти груп сортів сої за скоростиглістю, які придатні для вирощування в Україні – ультра скоростиглих, ранньостиглих, середньо ранньостиглих, середньостиглих та середньо пізньостиглих, саме група середньо ранньостиглих сортів з тривалістю вегетаційного періоду 106-125 діб, є найбільш чисельною за даними Державного реєстру сортів рослин України, придатних до вирощування, станом на 2021 рік. Сортів цієї групи стиглості – 160.

Найвищу урожайність насіння серед усіх середньо ранньостиглих сортів сої, за даними Державного реєстру сортів рослин, придатних для використання у 2021 році, мали сорти Подяка, Езра, Стайн 07Ж22, Саска, Сяйво, Сіпрес, Мальвіна, СВХ15Т1С1, ЕС Композитор, Турізас, Еліна. Найбільший вміст білка мали сорти РЖТ Сфорза, ДШ401, ЕС Башелор, Таурус, НС Діяна, ДШ863, Ленка, жиру – Шарм, Валюта, Браун, Спринт, Еверест, СГ Анзер. Значна частина середньо ранньостиглих сортів сої відзначаються високими балами посухостійкості, стійкості до хвороб, вилягання та осипання насіння, що становили 8 і більше та вказували на сприятливі параметри механізованого збирання та стійкої вегетації.

Ключові слова: соя, сорти, урожайність, технологічність, екологічність.