

DIFFERENTIATION OF MYRONIVKA SOFT WINTER WHEAT VARIETY ACCORDING TO VERNALIZATION REQUIREMENT

A. A. Siroshstan, O. V. Humeniuk, V. P. Kavunets, O. A. Zaima

The V. M Remeslo Myronivka Institute of Wheat, Tsentralne village, Obukhiv district, Kyiv region, 08853 Ukraine

Topicality. Among winter wheat varieties, there is a great diversity in the duration of the vernalisation period, which has a significant impact on the adaptation of plants to overwintering conditions. Therefore, the choice of varieties for sowing in the permissible and late dates depends on both frost hardiness and vernalisation requirement. **Purpose.** To study the features of the vernalization requirement for new varieties of soft winter wheat developed by the V. M Remeslo Myronivka Institute of Wheat. **Materials and Methods.** The duration of the vernalisation period was determined according to the methodology developed by the Biotechnology, Genetics and Physiology Department of the V. M. Remeslo Myronivka Institute of Wheat of NAAS. Sowing was carried out with winter wheat seeds that were artificially vernalised under controlled conditions in Petri dishes for different durations (from 10 to 50 days) at a temperature of 1–2 °C. Vernalised seeds were sown to a depth of 5 cm in the field conditions. The vernalisation period is considered sufficient to meet the vernalisation requirement of the variety if its plants have reached heading stage. **Results.** During three years of studying the vernalisation requirement of winter wheat varieties, it was found that 52 % of the studied varieties required vernalisation up to 30 days, 22 % required vernalisation from 30 to 40 days and 26 % required more than 40 days. The varieties MIP Kniazhna, MIP Valensiia, Hratiia Myronivska, MIP Dniprianka, MIP Assol, MIP Fortuna, MIP Lada, MIP Roksolana, MIP Darunok, and MIP Vidznaka are characterised by a short period of vernalisation, and the varieties Trudivnytsia Myronivska, Balada Myronivska, Estafeta Myronivska, MIP Yuvileina, MIP Nika are characterised by a long period of vernalisation. **Conclusions.** An objective assessment of the varietal characteristics takes into account both frost hardiness and vernalisation requirement. For late sowing of winter wheat, the varieties with short vernalisation period and frost hardiness of at least 6 points should be selected.

Key words: soft winter wheat, winter hardiness, vernalization requirement, varieties.

Introduction. The cultivation of soft winter wheat (*Triticum aestivum* L.) varieties with high frost tolerance and winter hardiness is important for obtaining high and stable yields. As reported by well-known scientists, winter hardiness of winter wheat plants is closely related to sowing dates [1–5].

Today, the shift of sowing dates to later dates is due not only to global warming, but also to the high saturation of crop rotations with non-traditional predecessors, which often delays soil preparation for an indefinite time [6–8]. Therefore, the selection of soft winter wheat varieties for sowing in optimal and late dates should be based on both frost tolerance and the duration of vernalisation, as varieties must pass the vernali-

sation at low temperatures from 0 to 5 °C for 25–30 days before the end of autumn growing season [9].

Winter wheat varieties have a wide range of vernalisation periods, which significantly affects the adaptation of winter wheat plants to the conditions of overwintering. Wheat can go through the vernalisation stage in the state of sprouted grain and seedlings. The vernalisation requires a complex of factors, including temperature, air humidity, and nutrients. During the vernalisation period, the germinating seed meets the need for nutrients from the plastic substances reserves of the endosperm, and the green plant meets the need for nutrients from their accumulation during photosynthesis.

Author information:

Andrii A. Siroshstan, Candidate of Agricultural Sciences, Head of the Department of Seed Production and Agricultural Technologies <https://orcid.org/0000-0003-3246-2907>

Oleksandr V. Humeniuk, Candidate of Agricultural Sciences, Head of the Winter Wheat Breeding Laboratory <https://orcid.org/0000-0002-1147-088X>

Valerii P. Kavunets, Candidate of Agricultural Sciences, Leading Researcher at the Department of Seed Production and Agricultural Technologies <https://orcid.org/0000-0002-6744-4947>

Oleksii A. Zaima, Candidate of Agricultural Sciences, Senior Researcher of the Department of Seed Production and Agricultural Technologies e-mail: oleksii.zaima@ukr.net. <https://orcid.org/0000-0001-5714-6308>

Vernalisation of winter wheat seedlings occurs only in the presence of light energy, as a prerequisite for photosynthesis [10].

The reason for the reduced yields of winter wheat due to the shift in sowing dates from the optimal ones is the unequal winter hardiness of different age plants. Stems that have passed the vernalisation stage and have not aged by the time the cessation of growing season occurs have high winter hardiness. Such stems are formed 22–42 days before the cessation of growing season. Therefore, too early or late sowing adversely affects vernalisation and, as a result, winter hardiness and yield of winter crops [11]. L.H. Makarov et al. studied the impact of sowing dates of winter wheat varieties with different vernalisation periods and concluded that the optimum sowing dates (15–25 September) provide the highest yields [12].

A. F. Stelmakh and V. I. Fait [13] report that modern wheat varieties and lines developed by the Plant Breeding and Genetics Institute showed a clear tendency to decrease the vernalisation period against the background of a decrease in the photosensitivity level compared to the old highly adapted varieties such as Odeska 16 and Myronivska 808. This raises reasonable concerns about the possible deterioration of their tolerance to negative winter temperatures. The decrease in adaptability can be overcome by shifting the optimal sowing dates to a later period, depending on the duration of the vernalisation period.

Modern winter wheat varieties of Myronivka selection are also mostly characterised by lower vernalisation requirements compared to varieties of the 70s and 80s of the last century [14, 15]. The short duration of winter wheat vernalisation (about 30–40 days) is not always associated with low frost resistance. It is possible to develop frost-resistant durum wheat varieties with short vernalisation periods. In this case, a reduction in the vernalisation period of modern winter wheat varieties will not have a fatal impact on their adaptive properties. Nevertheless, there was a clear shift in the breeding of varieties with a longer vernalisation period in the Czech Republic in 1990–2000 [16]. A longer vernalisation period causes slower development in the initial stages and the transition to the formation of a growth point and reproductive organs in such genotypes is observed later [17].

The longer period of transition to reproductive development determines both the level of plant tolerance to negative temperatures [18] and the duration of the period before the onset of this tolerance decline [19].

The lack of data on the peculiarities of the vernalisation period of most varieties included in the State Register prompted us to conduct relevant research.

The research was aimed at studying the peculiarities of vernalisation period in new varieties of soft winter wheat bred by the V. M. Remeslo Myronivka Institute of Wheat.

Materials and Methods. The vernalisation of soft winter wheat varieties was studied in 2019–2021. Sowing was carried out at the sowing dates of spring wheat. The duration of the vernalisation period was determined according to the method developed by the Department of Biotechnology, Genetics and Physiology of the V. M. Remeslo Myronivka Institute of Wheat [20]. Seeds for sowing are preliminarily subjected to artificial vernalisation of different durations (from 10 to 50 days), which was carried out under controlled conditions in Petri dishes at a temperature of 1–2 °C. The vernalised seeds were sown in field conditions to a depth of 5 cm (80 seeds per 1 linear metre). Each variety of winter wheat was sown in two-metre rows according to the duration of artificial vernalisation.

For each variant, the number of sprouted plants (field germination, %), the date of heading and the number of productive stems at the time of harvesting were recorded. To determine the possibility of additional vernalisation, germinated but not vernalised seeds of each variety were sown in the field. The vernalisation period of the variety was considered sufficient if most of the plants in the variant reached the heading stage.

Results and Discussion. An analysis of three-year experiment shows that 52 % of varieties had a short vernalisation period of up to 30 days, 22 % of varieties required vernalisation from 30 to 40 days and 26 % – more than 40 days (Table 1). The varieties MIP Kniazhna, MIP Valensiia, Hratsiia Myronivska, MIP Dniprianka, MIP Assol, MIP Fortuna, MIP Lada, MIP Roksolana, MIP Darunok, MIP Vidznaka are characterised by a short vernalisation period, while the varieties Trudivnytsia Myronivska, Balada Myronivska, Etafeta Myronivska, MIP Yuvileina, MIP Nika had a long

Table 1. Field germination and number of productive stems of winter wheat varieties depending on the seed vernalisation period, 2019–2021

Variety	Field germination, %						Number of productive stems, %					
	control	vernalisation period, days					control	vernalisation period, days				
		10	20	30	40	50		10	20	30	40	50
MIP Kniazhna	86	86	67	54	52	32	0	0	0	0.62	0.58	0.56
MIP Vyshyvanka	83	86	68	69	49	48	0	0	0	0.34	0.71	0.63
MIP Valensiia	80	76	58	55	50	26	0	0	0	0.72	0.60	0.55
Trudivnytsia Myronivska	87	76	65	56	40	36	0	0	0	0.44	0.82	0.83
Balada Myronivska	87	75	65	68	32	30	0	0	0	0	0.50	0.73
Hratsiia Myronivska	79	84	72	60	58	57	0	0	0	0.53	0.65	0.52
MIP Dniprianka	87	84	71	61	51	45	0	0	0	0.59	0.56	0.46
MIP Assol	85	78	71	49	46	44	0	0	0	0.51	0.47	0.45
Vezha Myronivska	83	83	66	60	40	38	0	0	0	0	1.00	1.11
Estafeta Myronivska	81	74	74	70	58	37	0	0	0	0	0.51	0.64
MIP Fortuna	88	86	80	83	67	58	0	0	0	0.36	0.41	0.44
Avrora Myronivska	88	81	68	63	37	37	0	0	0	0	0.54	0.59
MIP Yuvileina	76	74	71	68	60	52	0	0	0	0	0.16	0.61
MIP Lada	85	77	68	68	67	64	0	0	0	0.49	0.44	0.43
MIP Nika	81	75	58	55	40	40	0	0	0	0	0.30	0.55
MIP Roksolana	86	82	63	53	47	22	0	0	0	0.64	0.68	1.45
MIP Feieriia	82	77	80	68	46	43	0	0	0	0.36	0.63	0.60
MIP Darunok	86	71	65	52	48	41	0	0	0	0.54	0.52	0.51
MIP Vidznaka	88	76	77	63	59	40	0	0	0	0.56	0.54	0.50
Average	84	79	69	62	50	42	0	0	0	0.34	0.56	0.62

Note. Control (no vernalisation)

vernalisation period.

During 30 days of seed vernalisation, winter wheat plants formed 0.34–0.72 % of productive stems. When the seeds were kept at a temperature of 1–2 °C for 50 days, the number of productive stems was 0.43–1.45 %.

More productive stems for a short vernalisation period (30 days) were formed in varieties MIP Valensiia (0.72 %), MIP Roksolana (0.64 %) and MIP Kniazhna (0.62 %), and for a long vernalisation period (50 days) – in MIP Roksolana (1.45 %), Vezha Myronivska (1.11 %) and Trudivnytsia Myronivska (0.83 %) varieties.

It was found that increasing the vernalisation period of the sprouted seeds at a temperature of 1–2 °C to 50 days significantly reduced field germination. Thus, the seed germination rate in the control (without vernalisation) was 76–88 %, in variants with vernalisation for 10

days – 71–86 %, for 30 days – 49–83 %, for 50 days – 22–64 %. With prolonged vernalisation of seeds, the lowest decrease in field germination (by 21–30 %) was observed in varieties MIP Lada, MIP Fortuna, Hratsiia Myronivska and MIP Yuvileina.

Conclusions. For a more unbiased assessment of winter wheat varieties, it is recommended to include the vernalisation period in their description along with the frost tolerance index. When sowing winter wheat at a later date, the varieties with a short vernalisation period and frost tolerance of at least 6 points should be used, such as MIP Lada, MIP Fortuna and Hratsiia Myronivska. Among the varieties with a long vernalisation period, those should be selected for sowing whose seeds, when left in the soil for a long time in a sprouted state, slightly reduce field germination, in particular, the MIP Yuvileina variety.

References

1. Remeslo, V. M., Saiko, V. F. (1975). *Sortova ahrotekhnika pshenytsi* [Varietal agricultural technology of wheat]. Kyiv: Harvest. [in Ukrainian]
2. Fedorova, N. A. (1972). Causes of the death of winter crops in the Forest-steppe and Polesie of the Ukrainian SSR in the winter of 1971/72 and ways to increase

- winter hardiness of winter wheat. *Visnyk s.-h. nauky* [Bulletin of agricultural science], 1. 51–56. [in Ukrainian]
3. Fedorova, N. A., Bondarenko, V. M. (1983). Winter wheat and conditions of production. *Sortovaia ahrotekhnikha zernovykh kultur* [Varietal agricultural farm grain crops]. Kyiv: Harvest. 17–30. [in Russian]
 4. Demydov, O. A., Kochmarskyi, V. S., Kavunets, V. P. (2016). Terms of winter wheat sowing, recommendations and realities. *Propozytsiia* [Proposal], 10. 54–60. [in Ukrainian]
 5. Kyrychenko, V. V., Petrenkova, V. P., Kobyzieva, L. N. [ta in.]. (2016). *Osnovy upravlinnia produktsiinym protsesom polovykh kultur* [Fundamentals of field crop production process management]: Monograph. Edited by V.V. Kyrychenko. X: FOP Brovin O.V. [in Ukrainian]
 6. Saiko, V. F., Boiko, P. I. (2002). *Sivozminy v zemlerobstvi Ukrainy* [Crop rotation in agriculture of Ukraine]. Kyiv: Agrarian science. [in Ukrainian]
 7. Zubets, M. V. (2004). *Naukovi osnovy ahropromyslovoho vyrobnytstva v zoni Lisostepu Ukrainy* [Scientific basis of agro-industrial production in the zone of the Forest-steppe of Ukraine]. Redkol.: [M.V. Zubets (main), etc.]. Kyiv Logos. [in Ukrainian]
 8. Dieter Spar. (2012). *Zernovyye kultury. Vyrashchivanie, uborka, khraneniye i ispolzovaniye. 4-e izdanie, ispravlennoye* [Grain crops. Cultivation, cleaning, storage and use. 4th edition, corrected]. Publishing house "Grain." Kyiv. [in Russian]
 9. Vavilov N. I. (1987). *Teoreticheskiye osnovy selektsyi* [Theoretical basis of selection]. Moscow: Nauka. [in Russian]
 10. Shelepov, V. V., Gavrilyuk, N.N., Vergunov, V. A. (2013). *Pshenitsa: biologiya, selektsyya, morfologiya, semenovodstvo: monografiya* [Wheat: biology, selection, morphology, seed management: monograph]. Kyiv: Logos. [in Russian]
 11. Kovtun, Y. I., Goisa, N. I., Mitrofanov, B. A. (1990). *Optimizatsiya usloviy vozdeleyvaniya ozymoy pshenitsy po intensivnoy tekhnologii* [Optimization of conditions of winter wheat cultivation by intensive technology]. Leningrad: Hydrometeoizdat. [in Russian]
 12. Makarov, L. Kh., Snitina, S. M., Skoryi, M. V. (2006). Productivity of different varieties of winter wheat depending on the terms of sowing. *Zroshuvalne zemlerobstvo* [Irrigation farming], 46. 46–48. [in Ukrainian]
 13. Stelmakh, A. F., Fait, V. I. (2007). Genetic and physiological reactions of delay of initial development in modern winter wheat and barley. *Dosiahnennia i problemy henetyky, selektsii ta biotekhnolohii* [Achievements and problems of genetics, selection and biotechnology]. Science. etc. Society of Geneticists and Breeders named after N. I. Vavilov; Ed. Kunakh V. A. and other. Kyiv: Logos, 2. 46–48. [in Ukrainian]
 14. Bulavka, N. V. (2010). Vernalization requirement need, photoperiodic sensitivity and the relationship of these features with frost resistance in Mironovsky varieties of soft winter wheat. *Naukovo-tekhnologichnyi biuleten Myronivskoho in-tu pshenitsy* [Science and Technology bul. of Myronivka instytut of wheat]. Mironivka, 10. 59–65. [in Ukrainian]
 15. Siroshstan, A. A., Kavunets, V. P., Bulavka, N. V. (2016). Spring-growing need for winter soft wheat varieties. *Myronivskiy visnyk* [Mironovsky Herald]. Mironivka, 3. 148–159. [in Ukrainian]
 16. Petr, J., Hnilicka, F. (2002). Changes in requirements on vernalization of winter wheat varieties in the Czech republic in 1950–2000. *Rostl. Vyroba*, 48 (4). 148–153.
 17. Prasil, I. T., Prasilova, P., Pankova, K. (2004). Relationships among vernalization shoot apex development and frost tolerance in wheat. *Annals of Botany*, 94. 413–418.
 18. Prasil, I. T., Prasilova, P., Pankova, K. (2005). The relationship between vernalization requirement and frost tolerance in substitution lines of wheat. *Biologia Plantarum*, 49 (2). 195–200.
 19. Mahfoozi, S., Limin, A. E, Fowler, D. B. (2001). Influence of vernalization and photoperiod responses on cold hardiness in winter cereals. *Crop Science*, 41. 1006–1011.
 20. Demydov, O. A., Bulavka, H. V., Yurchenko, T. V., Pirykh, A. V., Humeniuk, O. V. (2019). Determination of the duration of the vernalization requirement need and photoperiodic sensitivity of soft winter wheat samples (*Triticum aestivum* L.) (Guidelines). Ed. by O. A. Demydov. Myronivka: N. p. 11 p. [in Ukrainian]

УДК 633.11:631.531.027.325

Сіроштан А. А., Гуменюк О. В., Кавунець В. П., Заїма О. А. Диференціація миронівського сорто типу пшениці м'якої озимої за яровизаційною потребою.

Зернові культури. 2024. 8 (1). 114–118.

Миронівський інститут пшениці імені В.М. Ремесла НААН, с. Центральне, Обухівський р-н., Київська обл., 08853, Україна

Актуальність. Серед сортів пшениці озимої спостерігається широке різноманіття за тривалістю періоду яровизації, що значно впливає на адаптацію рослин до умов зимівлі. Отже, при виборі сортів для сівби в допустимі та пізні строки необхідно знати крім показника морозостійкості також тривалість яровизаційної потреби. **Мета.** Дослідити особливості яровизаційної потреби нових сортів пшениці м'якої озимої селекції Миронівського інституту пшениці імені В. М. Ремесла. **Матеріали та методи.** Визначення тривалості періоду яровизації проводили за методикою, розробленою у відділі біотехнології, генетики і фізіології Миронівського інституту пшениці імені В.М. Ремесла. Для сівби брали насіння, що пройшло попередню штучну яровизацію, яку здійснювали в контрольованих умовах в чашках Петрі за різної тривалості (від 10 до 50 діб) за температури 1–2 °С. Яровизоване насіння висівали в польових умовах у ґрунт на глибину 5 см. Строк яровизації

вважався достатнім для потреби сорту, якщо у варіанті більша частина рослин сортозразка виколошувалася. **Результати.** За три роки вивчення питання яровизаційної потреби сортів пшениці озимої встановлено, що 52 % сортів мали коротку яровизаційну потребу до 30 діб, 22 % – потребували яровизації від 30 до 40 діб і 26 % – більше 40 діб. Сорти МП Княжна, МП Валенсія, Грація миронівська, МП Дніпрянка, МП Ассоль, МП Фортуна, МП Лада, МП Роксолана, МП Дарунок, МП Відзнака мають коротку яровизаційну потребу, а сорти Трудівниця миронівська, Балада миронівська, Естафета миронівська, МП Ювілейна, МП Ніка – тривалу яровизаційну потребу. **Висновки.** Для більш об'єктивної оцінки сортів поряд з показником морозостійкості у їх характеристиці доцільно наводити також яровизаційну потребу. За сівби пшениці озимої в пізні строки необхідно використовувати сорти з коротким періодом яровизації та морозостійкістю не нижче 6 балів.

Ключові слова: пшениця м'яка озима, зимостійкість, яровизаційна потреба, сорти