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DYNAMICS OF GROWTH PROCESSES OF WINTER WHEAT VARIETIES UNDER DIFFERENT NUTRITION BACKGROUNDS AND WEATHER CONDITIONS OF THE YEAR IN SOUTHERN UKRAINE

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In the context of modern climate change and the growing need to ensure food security, research into adaptive technologies for growing winter wheat is becoming particularly important. Frequent droughts, temperature fluctuations and unstable weather conditions necessitate the development of new approaches to fertilization and the optimization of agrotechnical measures.

The aim of this work is to scientifically substantiate and experimentally verify the effectiveness of agrotechnical measures for growing winter wheat under different weather conditions throughout the year, taking into account the biological characteristics of modern varieties.

To achieve this goal, the research programmer included the following tasks: to study the influence of the nutritional background and weather conditions of the year on the dynamics of growth processes of winter wheat varieties.

Research methods: field, laboratory, statistical, comparative.

The study is three-factor, including the following factors and variants: Factor A (varieties) – Nikonia; Kuyalnik; Factor B (nutrient background): 1 – without fertilizers; 2 – calculated dose of 7.0 t/ha ($N_{120}P_{90}$); *3 – calculated dose of 9.0 t/ha* ($N_{150}P_{120}$); *Factor C – weather conditions of the year (2022, 2023, 2024).*

The results of the studies showed that the accumulation of dry biomass by winter wheat plants depended on the stage of development, nutrient background and variety. Thus, on average for all years of research, in the variant of the calculated fertilizer dose for a grain yield of 7.0 t/ha, winter wheat plants of the Nikonia variety accumulated 638.3 g/m^2 of dry matter during the stem elongation phase, and at 9 t/ha – 789.4 g/m^2, while when growing plants without fertilisers, only 473.7 g/m^2 of dry biomass was accumulated. Plants of the winter wheat variety Kuyalnik formed practically the same amount of dry aboveground mass, with the indicated indicators amounting to 597.3, 711.0 and 451.0 g/m^2, respectively, or slightly less than those for the Nikonia variety.

Thus, under the conditions of the experiment, the largest above-ground mass of winter wheat plants of the Nikonia variety was formed in the variants of applying the $N_{150}P_{120}$ *fertilizer dose in the most favorable weather conditions of 2023.*

Further research should be aimed at a comprehensive study of the interaction of nutrition, climate and varietal characteristics, which will increase the stability of yield and grain quality.

Key words: *winter wheat, variety, nutrient background, growth dynamics, weather conditions, plant height.*

Минкіна Г. О. Динаміка ростових процесів сортів пшениці озимої за різних фонів живлення та погодних умов року півдня України

В умовах сучасних кліматичних трансформацій та потреби що зростає у забезпеченні продовольчої безпеки особливого значення набувають дослідження адаптивних технологій вирощування пшениці озимої. Часті прояви посухи, температурні коливання та нестабільність погодних факторів зумовлюють необхідність розробки нових підходів до системи удобрення та оптимізації агротехнічних заходів.

Метою роботи є наукове обґрунтування та експериментальна перевірка ефективності агротехнічних заходів вирощування озимої пшениці за різних погодних умов року з урахуванням біологічних особливостей сучасних сортів.

Для досягнення поставленої мети програмою досліджень передбачались такі завдання: вивчити вплив фону живлення та погодних умов року на динаміку ростових процесів сортів пшениці озимої.

Методи дослідження: польові, лабораторні, статистичні, порівняльні.

Дослід трифакторний, включає такі фактори та варіанти: Фактор А (сорти) – Ніконія; Куяльник; Фактор В(фон живлення): 1 – без добрив; 2 – розрахункова доза на 7,0 т/га ($N_{120}P_{90}$); *3 – розрахункова доза на 9,0 т/га* ($N_{150}P_{120}$); *Фактор С – погодні умови року(2022,2023,2024).*

Результати досліджень показали, що накопичення сухої біомаси рослинами пшениці озимої залежало від фази розвитку, фону живлення та сорту. Так, у середньому за всі роки досліджень у варіанті розрахункової дози добрив на рівень урожайності зерна 7,0 т/га у фазу виходу рослин пшениці озимої сорту Ніконія у трубку вони накопичили сухої речовини 638,3 г/м^2, а на 9 т/га – 789,4 г/м^2, тоді як за вирощування рослин без добрив сухої біомаси накопичилося лише 473,7 г/м^2. Рослини сорту пшениці озимої Куяльник формували практично таку ж кількість сухої надземної маси, зазначені показники відповідно склали 597,3; 711,0 та 451,0 г/м^2, або виявилися дещо меншими порівняно з аналогічними для сорту Ніконія.

Таким чином в умовах проведення досліду найбільшу надземну масу рослини пшениці озимої сорту Ніконія формували на варіантах застосування дози добрив $N_{150}P_{120}$ *у найбільш сприятливий за погодними умовами 2023 рік.*

Подальші дослідження мають бути спрямовані на комплексне вивчення взаємодії факторів живлення, клімату та сортових особливостей, що дозволить підвищити стабільність урожайності та якість зерна.

Ключові слова: *пшениця озима, сорт, фон живлення, динаміка росту, погодні умови, висота рослин.*

Statement of the problem. Problem statement. In the current context of global climate change and growing demand for food security, research into adaptive technologies for winter wheat cultivation is becoming particularly important. Frequent droughts, temperature stresses and unstable weather conditions require new approaches to fertilisation and agrotechnical management. For Ukraine, which is one of the key exporters of grain crops, ensuring stable yields and high quality of winter wheat is of strategic importance for both the domestic market and international trade.

Modern winter wheat varieties have high productivity potential, but this can only be realised through the application of optimal agrotechnical measures that correspond to the biological characteristics of the crop. The growth and development processes of wheat are multifactorial and depend on the interaction of the genotype with the weather conditions of the year.

Among the key factors determining the growth and development of winter wheat, weather conditions and fertilisation play a particularly important role. Their constant influence requires in-depth analysis, both in terms of their interaction and separately, as they determine the quantitative parameters of above-ground mass, which ensures production stability.

Scientific research and practical experience in the field of agricultural production prove that high productivity rates of modern winter wheat varieties are only possible with the correct application of agrotechnical measures that are consistent with its biological characteristics. The processes of growth and development of this crop are complex and multifaceted, so without taking into account the response of a specific genotype to a set of agrotechnical measures in certain soil, climatic and weather conditions, it is difficult to predict the results. That is why conducting such research in different natural zones remains extremely relevant.

Analysis of recent studies and publications. The state of research on this issue shows that the productivity of winter wheat in southern Ukraine largely depends on

a combination of agrotechnical measures, nutrient levels, and weather conditions during the year. Research is being conducted to optimise fertilisation systems and adapt varieties to climatic challenges.

Above-ground mass is quite important in the life of plants. They mobilise carbohydrates, nitrogenous and other substances from it to form the productive part of the crop. Therefore, starting from the first stages of development, the accumulation of large vegetative mass of plants is an important condition for the formation of a high yield. Smirnova I. V. notes a direct relationship between wheat grain yield and the mass of vegetative organs. The above-ground mass of plants plays a particularly important role in southern Ukraine, where a significant part of the leaf apparatus dies off before the wheat grain filling period [1]. According to scientists, if the overall habitus of plants is achieved by creating the best conditions for lighting, moisture and nutrition, then their productivity will be maximised [2].

The author [3] emphasises that optimal provision of nutrients to plants is the basis for high winter wheat productivity. He notes that nitrogen fertilisers have the greatest impact on the intensity of growth processes, while phosphorus and potassium provide resistance to adverse conditions.

Gamayunova V. V. et al. indicate that the fertilisation system must be adapted to specific soil and climatic conditions, as an excess or deficiency of nutrients can lead to a decrease in grain quality [4].

S. O. Kalenska proves in her works that the dynamics of winter wheat growth processes largely depend on the temperature regime in the spring-summer period. She points out that high temperatures during the grain filling phase lead to a decrease in the weight of 1000 grains. The climate of southern Ukraine is characterised by frequent spring droughts, which significantly affect the tillering phase. She emphasises that even with optimal nutrition, a lack of moisture can reduce yields by 25–30 % [5].

Y. O. Tarariko emphasises that weather conditions are a decisive factor in yield stability and determine the effectiveness of fertiliser use. He believes that a combination of drought-resistant varieties and optimised nutrition systems is relevant for southern Ukraine [6].

V. M. Pysarenko stresses that research should focus on studying the interaction between weather conditions and agrotechnical measures, as only a comprehensive approach can achieve stable results [7].

The author notes that adapting cultivation technologies to the climatic risks of southern Ukraine is a key task for modern agricultural science [8].

Absolute values of above-ground mass growth are external indicators of internal processes occurring in plants. Therefore, it is fair to judge the impact of a particular factor on a plant by the rate of above-ground mass growth. To a large extent, the intensity of biomass accumulation by plants depends on the level of mineral nutrition. The use of high doses of nitrogen significantly increases the above-ground mass of wheat, but at the same time reduces grain yield and protein content. Therefore, in sufficiently humid and not hot climates, grain crops require moderate nitrogen nutrition.

Thus, the authors agree that the nutritional background creates productivity potential, but its realisation depends on the weather conditions of the year. Droughts and high temperatures remain the main limiting factors for southern Ukraine.

Problem statement. The productivity of any agricultural crop is influenced by many factors, including those under study, and develops systematically throughout the entire growing season. Research on the production processes of winter wheat varieties was aimed at determining the influence of the studied factors – fertilisers and weather conditions of the year – on the processes of growth and development and the

accumulation of vegetative mass. Observations of the growth of above-ground plant mass, leaf area, and linear height showed that these indicators depended on and changed under the influence of the studied factors and throughout the growing season.

The objectives of the study were: to analyse the influence of weather conditions and fertilisation systems on the growth and development of winter wheat varieties; to evaluate the effectiveness of fertiliser application and its role in the formation of above-ground plant mass; to develop recommendations for optimising winter wheat cultivation technology to ensure stable productivity in the context of climate change.

Object of study. Processes of growth, development and formation of above-ground mass of winter wheat varieties under different weather conditions and nutrient backgrounds.

Subject of study. Influence of agrotechnical measures on the formation of above-ground mass of winter wheat.

Research methods: field experiments – establishment of experimental plots with different fertilisation systems and varieties under different weather conditions throughout the year; laboratory analyses – determination of phenological and biometric indicators of growth and development of winter wheat varieties; statistical methods – mathematical processing of research results; comparative analysis – evaluation of the effectiveness of agrotechnical measures under different weather conditions throughout the year.

The research was conducted during 2022–2024 on southern chernozem at the Chas farm in the village of Novomykolaivka, Beryslav district, Kherson region. The 0–30 cm soil layer contains 2.9–3.4 % humus, 25–30 mg/kg of mobile nitrogen, 40–45 mg/kg of P_2O_5 and 370–520 mg/kg of K_2O.

The experiment is three-factor, including the following factors and variants: Factor A (varieties) – Nikonia; Kuyalnik; Factor B (nutrient background): 1 – without fertilisers; 2 – calculated dose of 7.0 t/ha ($N_{120}P_{90}$); 3 – calculated dose of 9.0 t/ha ($N_{150}P_{120}$); Factor C – weather conditions of the year (2022, 2023, 2024).

The total area of the plot is 80 m², the recorded area is 50 m², and the experiment is repeated four times. The total area of the experimental field per year is 1950 m² per year. The variants are arranged sequentially.

The agricultural technology used to grow winter wheat in the experiment was generally accepted for the conditions of the region, except for the factors under study.

Peas were the predecessor of winter wheat in the experiment. Post-harvest residues were ploughed into the soil to enrich it with organic matter and biological nitrogen.

Research, observation of plant condition, and sampling for biometric indicators were carried out in accordance with research methods and regional methodological recommendations [9; 10; 11].

Presentation of the main research material. During the years when we conducted research on the winter wheat varieties Nikonia and Kuyalnik, winter wheat plants grown on fertilised soils were significantly taller. If unfertilised plants of the Nikonia winter wheat variety at the beginning of stem elongation, depending on the year of research, reached a height of 23.6–34.0 cm, then at the beginning of heading this indicator increased to 36.5–88.2 cm. The application of mineral fertilisers significantly affected the height of winter wheat plants, increasing it to 32.0–40.9 cm and 54.0–99.5 cm in the Nikonia variety, respectively (Fig. 1).

Similarly, the height of winter wheat plants of the Kuyalnik variety changed under the influence of the studied factors and years of research (Fig. 2).

Again, the plants were the shortest in the severely dry year of 2022. The application of mineral fertilisers in that year, compared to other years of research, significantly

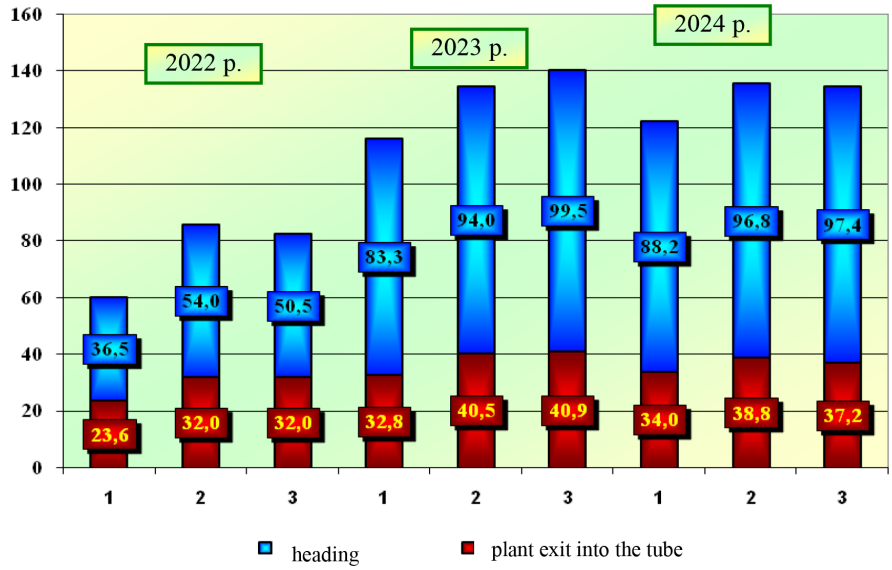

Fig. 1. Influence of nutritional background and weather conditions of the years of research on the height of winter wheat plants of the Nikonia variety, cm

Notes: 1 – without fertilizers; 2 – calculated dose for 7.0 t/ha; 3 – calculated dose for 9.0 t/ha

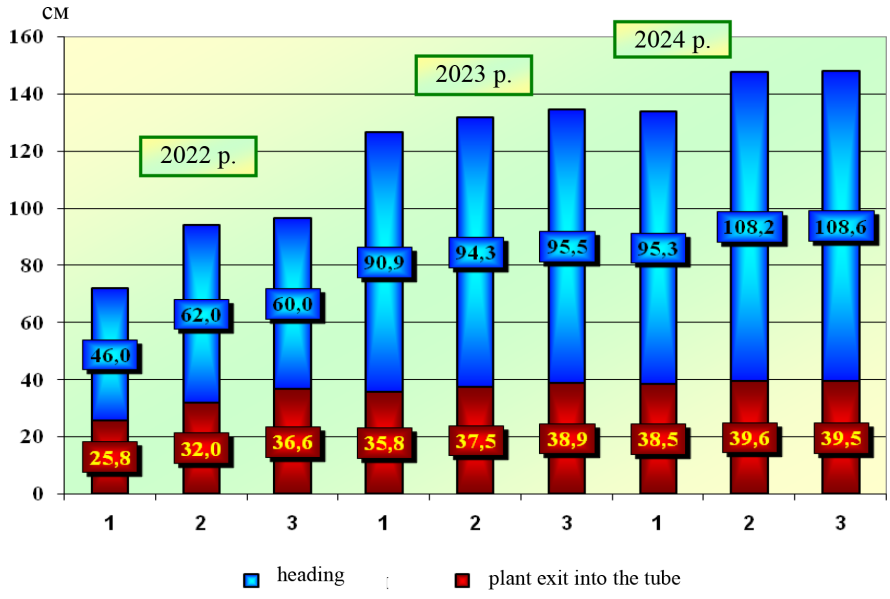

Fig. 2. The influence of fertilizers and weather conditions of the year on the height of winter wheat plants of the Kuyalnik variety, cm

Notes: 1 – without fertilizers; 2 – calculated dose for 7.0 t/ha; 3 – calculated dose for 9.0 t/ha

increased this indicator. Thus, during the earing period in the cultivation of the Kuyalnik winter wheat variety, the height of unfertilised plants was 46.0 cm, and after fertilisation, it increased to 60–62 cm, or by 30.4–34.7 %. In 2024, unfertilised winter wheat plants reached a height of 95.3 cm, while fertilised plants reached 108.2–108.6 cm, or an increase of only 13.9 %. The growth of total plant biomass is important in the formation of the economically valuable part of the crop yield.

Absolute indicators of above-ground mass growth are external indicators of the production processes taking place in them. To a large extent, the intensity of biomass accumulation by plants depends on growing conditions. The most important role in the formation of this indicator belongs to the mineral nutrition of plants. It is from the above-ground mass that plants mobilise carbohydrates, nitrogenous and other substances.

In the first days after the resumption of spring vegetation, the intensity of above-ground mass accumulation by both varieties was low.

Already in the phase of plant emergence, the rate of above-ground biomass accumulation by winter wheat plants increases and significantly depends on the nutritional background and weather conditions of the years of research. The data show that in the severely dry year of 2022, above-ground mass accumulated during the stem elongation phase was almost 7–8 times less than in subsequent years of research.

In the dry year of 2022, the plants of the winter wheat varieties we studied accumulated significantly less raw above-ground mass during all major vegetation periods than in other years of observation.

The study of the influence of weather conditions of the year and the differentiation of the mineral nutrition background on the dynamics of plant mass accumulation in two varieties of winter wheat revealed some discrepancies.

No significant regular differences between the winter wheat varieties studied were observed in this indicator. However, in most periods of sampling and determination of vegetative mass, it was slightly higher in plants of the Nikonia variety.

The application of mineral fertilisers had a positive effect on the growth of above-ground plant biomass, which increased depending on the dose of mineral nutrition applied to winter wheat. This dependence was observed even in the severely drought-stricken and unfavourable weather conditions of 2022.

In the same way as the growth of raw plant biomass, the amount of dry matter also accumulated, since this indicator is determined by calculation and depends on the moisture content of the plant mass during the growing season and its yield per unit area.

The accumulation of dry biomass by winter wheat plants depended on the stage of development, nutritional background and variety. Thus, on average for all years of research, in the variant of the calculated fertilizer dose for a grain yield of 7.0 t/ha, winter wheat plants of the Nikonia variety accumulated 638.3 g/m^2 of dry matter during the stem elongation phase, and at 9 t/ha – 789.4 g/m^2, while when growing plants without fertilisers, only 473.7 g/m^2 of dry biomass was accumulated. Plants of the winter wheat variety Kuyalnik formed practically the same amount of dry above-ground mass, with the indicated indicators amounting to 597.3, 711.0 and 451.0 g/m^2, respectively, or slightly less than those for the Nikonia variety.

Conclusions. Our research and calculations showed that mineral nutrition and weather conditions of the year influenced the dynamics of growth processes of winter wheat crops.

The growth and development of winter wheat varieties depended on the factors studied, namely nutrition and varieties, and very significantly on the weather conditions of the years of research.

Winter wheat plants grown on mineral fertiliser backgrounds were significantly taller. Thus, during the stem elongation period, unfertilised plants of the Nikonia variety reached a height of 23.6–34.0 cm, and on fertilised soils 32.0–40.9 cm. In further vegetation at the beginning of earing, these indicators were 36.5–88.2 and 54.0–99.5 cm, respectively.

The lowest height was observed in plants of the studied winter wheat varieties in the sharply arid and least favourable weather conditions of 2022. The plants reached their maximum height in all periods of determination when grown with the calculated fertilizer dose for a grain yield of 9.0 t/ha ($N_{150}P_{120}$).

Thus, under the conditions of the experiment, the largest above-ground mass of winter wheat plants of the Nikonia variety was formed in the variants of applying the $N_{150}P_{120}$ fertilizer dose in the most favorable weather conditions of 2023.

Further research should be aimed at a comprehensive study of the interaction of nutrition, climate and varietal characteristics, which will increase the stability of yield and grain quality.

REFERENCES:

1. Смірнова І. В. Продуктивність сортів пшениці озимої залежно від фону живлення в умовах Південного степу України : автореф. дис. канд. с.-г. наук : Миколаїв: Миколаївський національний аграрний університет, 2021. 20 с.
2. Ріст і розвиток пшениці озимої у весняно-літній період вегетації залежно від умов мінерального живлення в Правобережному Лісостепу України / Господаренко Г.М. та ін., Умань: Вісник Уманського національного університету садівництва № 1, 2020. С. 45–52.
3. Мунтян О. В. Вплив азотного живлення та погодних умов на формування елементів продуктивності озимої пшениці в умовах Півдня України : дис. канд. с.-г. наук : Херсон: Херсонський державний аграрний університет, 2019. 180 с.
4. Гамаюнова В. В., Коковіхін С. В. Агротехнічні прийоми вирощування озимої пшениці в умовах Південного степу України : монографія. Айлант. Херсон, 2018. 240 с.
5. Каленська С. О. Вплив кліматичних умов на продуктивність зернових культур у степовій зоні України: Наукові праці Національного університету біоресурсів і природокористування України. Вип. 12. Київ, 2017. С. 112–118.
6. Тараріко Ю. О. Адаптація технологій вирощування озимої пшениці до кліматичних ризиків Півдня України : монографія. Київ : Інститут землеробства НААН, 2016. 198 с.
7. Писаренко В. М. Система удобрення та її роль у формуванні врожайності озимої пшениці : навч. посіб. Полтава, 2015. 156 с.
8. Минкіна Г. О. Залежність ураженості посівів озимої пшениці від застосування хімічних засобів та фону живлення в умовах Півдня України : Таврійський науковий вісник. Сільськогосподарські науки. Херсон, 2023. DOI https://doi.org/10.32782/2226-0099.2023.131.20 Вип. 131. С. 161–168.
9. Дослідна справа в агрономії : навчальний посібник : у 2 кн. Кн. 1. / А. О. Рожков та ін.; за ред. А. О. Рожкова. Харків, 2016. 316 с.
10. Дослідна справа в агрономії: навчальний посібник: у 2 кн. Кн. 2. / А. О. Рожков та ін.; за ред. А. О. Рожкова. Харків, 2016. 342 с.
11. Ушкаренко В. О., Вожегова Р. А., Голобородько С. П., Коковіхін С. В. Методика польового досліду: навчальний посібник. Херсон : Грінь Д.С., 2014. 448 с.

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