UDC 631.53.04:632.931.2:633.11"324"(477.7)

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PRODUCTIVITY OF SOFT WINTER WHEAT SORT DEPENDING ON TERMS LENGTH OF SOWING AND WEATHER IN SPRING-SUMMER PERIOD

Вивчено вплив строків сівби і погодних умов весняно-літнього періоду на формування продуктивності сучасних сортів пшениці озимої в умовах Південного Степу України. Встановлено, що основну роль у формуванні продуктивності цієї культури в весняно-літній період відіграє тривалість міжфазного періоду «відновлення весняного кущіння-колосіння», який був самим коротким (64-65 діб) у 2013 році, сума ефективних температур при цьому склала 390,4-406,0 °С, а найдовшим (82-88 діб) – у 2015 році, що обумовлено кращими погодними умовами під час вегетації. Висота рослин пшениці озимої знижувалася з ранніх до пізніх строків сівби в середньому по сортах на 7,4 см. Найкращі умови для росту та развитку рослин пшениці озимої склалися у 2014 році, коли висота рослин досліджуваних сортів досягала в середньому по строках сівби 75,2 см (Овідій) та 75,8 см (Місія одеська). Досліджувані сорти пшениці озимої сформували найбільшу кількість продуктивних стебел (997 і 959 шт./м²) в 2014 році за сівби 30 вересня. Найнижчий продуктивний стеблостій (512-614 шт./м²) сформували досліджувані сорти в 2015 році за сівби 10 жовтня. Дослідженнями встановлено, що найоптимальніші погодні умови в період «колосіння – молочна стиглість зерна» пшениці озимої були в 2013 році за сівби 10 жовтня. Найвища урожайність зерна пшениці озимої (6,40 т/га) сформувалася у 2015 році за сівби сортом Місія одеська у строк 30 вересня. У 2013-2014 роках найвищий урожай зерна досліджуваних сортів було зібрано за сівби 10 жовтня, що на 0,15-0,41 т/га перевищило контроль – 30 вересня.

Ключові слова: пшениця озима, сорт, строки сівби, кількість продуктивних стебел, висота рослин, врожайність.

Introduction. Due to the rapid global increase of the population, the demand on grain’s cultivation as the main food is also increased. Today, wheat is grown at every continent in the world [1-5]. In Ukraine it is the main crop, under which the area annually reaches 6.7-7.3 million hectares. Up to 90% of the area is concentrated in the Steppe and Forest Steppe Zones [6-8].

In recent years, our country presents confidently itself in the world grain market by increasing content of grain exports, including winter wheat [9-11]. In 2013, we took the eighth place among the world's largest exporters, and in 2014 – the sixth, exporting 10.5 million tons of wheat (44% of total production) [12, 13].

However, it should be hoticed that the yield of this crop is much lower than in many other developed countries of the world, which is connectedwith the non-observance technology of crop's cultivation, particularly the sowing terms [11-13].

Analysis of recent research and publications. In recent years, a number of scientific institutions in Ukraine and the world came come to the conclusion that due to climate change, deterioration of the phytosanitary state of the fields and the biological characteristics of new varieties in production (shortening the period of vinification), the terms of sowing require constant research for each new variety [14-16].

The during out researches we established that for each agro-climatic zone, the right lines of winter wheat seeding are important for both favorable and unfavorable years. However, in the scientific literature there are quite different recommendations.

Thus, M.P. Yavdoshchenko [17] found that more resistant to diseases of the wheat varieties of soft winter can be sown in admissible early and late terms without significant risk of losing their diseases and reducing the grain yield.

By Studing researches of R. A. Vozhegova, S. O. Zaitsev and others [18] we established that in the conditions of the Southern Steppe for the cultivation of winter wheat in a "black fallow" at the beginning of the optimal seeding period (from September 15) Ovidiy and Kohana varieties may be

sown, and at the end of the optimal and admissible (October 5 and 15) - Khersonskaya Bezosta, which in case of delay with sowing will provide higher yield than other varieties.

The purpose of the research to was the investigate the influence of sowing terms and weather conditions of the spring-summer period on the formation of the main elements of the productivity of soft winter wheat.

Materials and methods. The researches were carried out during 2012-2015 on the experimental field of Educational and Scientific-Practical Center of Mykolayiv National Agrarian University (ESPC MNAU).

Field studies were laid out and executed taking into account all the requirements of the research methodology. The total area of the sown area is 50 m², the registration area is 25 m². Repeat threefold.

Soil test sites are southern black soil. The subjects of research are the varieties of winter wheat – Odesyka Misiya and Ovidiy, zoned in the South of Ukraine [19-21]. Cultivars were sown in three terms – on September 20th, 30th and on October 10th. The forecrop is the fallow. Winter wheat’s growing technology was common for the South Steppe of Ukraine except the elements of agrotechnics, which have been put on the study.

Phenological observations, the definition of plant height, number of productive stalks, winter wheat were carried out according to the procedure of the state strain testing of crops [22].

Results and discussion. It is known that during the late spring the plants are grown at an elevated ambient temperature (8-10 °C) and more solar energy, while there is a rapid temperature’s increase, which in turn degrades the regenerative processes, inhibits the growth of shoots cause partly or total death of plants. In early spring vegetation of winter wheat before the release of the tube take place at low temperatures (4-7 °C), which are slowly increasing. It is favorable for the re-growth of plants, regeneration of damaged organs, and passing of all growth processes [23, 24].

According to long-term data in Ukraine the winter growing season resumes, first in the Crimea – on March of 15-17th of March, Kherson and Odessa regions – on March 18-20th, Mykolayiv – on March 20th-23^{d}, Kirovohrad, Dnipropetrovsk and Zaporizhzhya – on March 23-25th, Donetsk – on March 30-31th, Lugansk – on April 1th-3^{d}. But in the recent years, due to the warming, the average date of the vegetation resumption was shifted [25].

We have found that over the past 12 years (2003-2015), the earliest resumption of the growing season of winter wheat in Mykolayiv region was in 2008 (February, 6) and the latest recorded in 2003 (April, 6). During our research the resumption of the spring growing season in 2013 was marked on March 9th, 2014 – on March 6th, 2015 – on February 28th (Table 1).

Table 1 – **Characteristics of the interphase period "the renewal of spring tillering – heading" of winter wheat depending on sowing time and temperature conditions**

Key figures	Years of research	Dates of sowing		
		20.09	30.09	10.10
Date of renewal of spring tillering	2013	9.03	9.03	9.03
	2014	6.03	6.03	6.03
	2015	28.02	28.02	28.02
The date of the phase "the beginning of heading "	2013	11.05	11.05	12.05
	2014	11.05	14.05	17.05
	2015	20.05	23.05	26.05
The duration of phase to phase period, days	2013	64	64	65
	2014	67	70	73
	2015	82	85	88
The sum of effective temperatures, °C	2013	390,4	390,4	406,0
	2014	364,4	396,4	436,2
	2015	356,3	404,6	454,4
The sediments of rainfall in mm	2013	32	32	32
	2014	58	60	84
	2015	153	153	153

The researched sorts of plants started to head up at the same time. It was found that sowing dates significantly affect the offensive phase heading.

We found that the interphase period «the renewal of spring tillering – heading» of the winter wheat significantly depends on the weather and the spring sowing time period. In 2013 this period was rather

short (64-65 days), which is justified by the early persistent transition of daily average temperature over 15 °C, which is for 16 days earlier than the multi-year periods. In addition, the reduction in interphase periods of drought due to dirt, and the sum of effective temperatures at the same time was 390,4-406,0 °C.

The period of «restoration spring tillering – heading» in 2014 had amounted up to 67-73 days with the sum of effective temperatures 364,4-436,2 °C. The most prolonged of the interphase period was (82-88 days), was in 2015, due to better weather conditions during the growing season. The beginning of heading was observed on May 20th - September 20th at sowing, on May 23^{d} – September 30th at sowing, on May 26th – October 10th.

There is no the same opinion among scientists as to what should be the optimum height of the winter wheat plant. The short stature varieties can be influenced by less prone of lodging than the tall sorts. They form a smaller mass per unit of vegetative crop, so they use less of soil nutrients. On the other hand, tall crops much better control weed's growth and development, so they need to use less herbicides and so they assure higher yield of straw per unit area as an organic fertilizer [26-28].

It was found that the height of winter wheat is significantly affected by sowing time. More temples, this figure was generated in plants of the first winter sowing period (September 20th), in average of three years, 75.3 cm class Ovidiy and 76.4 cm for class a Odesyka Misiy (Table 2).

Table 2 – **Height of winter wheat depending on the varietal characteristics and times of sowing timing,** 2013-2015 pp.

Variety (factor A)	Sowing dates (factor B)			Average of factor B
	20.09	30.09	10.10	
Odesyka Misiya	77,0	72,7	69,5	73,1
Ovidiy	74,7	71,9	68,4	71,7
Average of factor A	75,9	72,3	69,9	72,7

Lowest winter wheat crops formed from the closing date of sowing (10.x) – 69,5 cm class Mission Odessa and 68,4 cm for class Ovid. The plant height decreased from early to late sowing dates in the average grades of 7.4 cm.

It was found that the height of the plants is also affected by the weather conditions. The most favorable for the growth and development of winter wheat plants were weather conditions in 2014, when the height of the plants of studied varieties reached the time of sowing in average 75.2 cm (Ovidiy) and 75.8 cm (Odesyka Misiya). The least favorable for the growth and development of winter wheat was 2013, the height of plants at the same time on grades was 71.4 cm – Odesyka Misiya and 68.4 cm – Ovidiy (Figure 1).

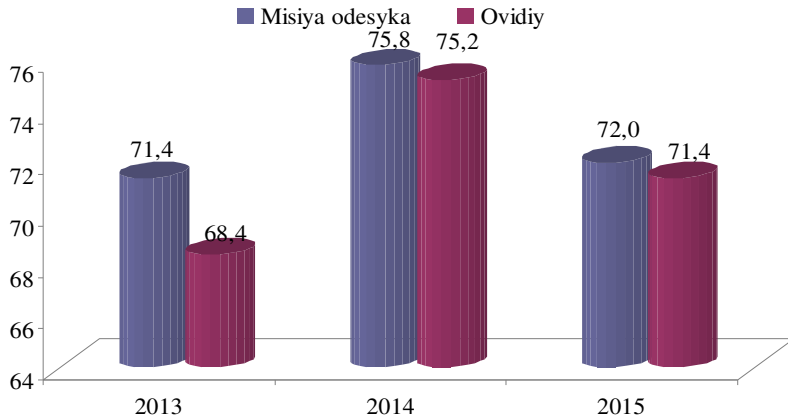

Fig. 1. **The height of the winter wheat plants in wax ripeness of grain, depending on the grade during gears of study.**

The number of productive stems per unit area is the most important element of the yield structure which is formed by seeding rate, seed germination, temperature, moisture and total productive tillering and plant survival [29-32].

The results of our research show that planting dates affect the formation of the density of productive stalks, because plants were in different weather conditions. In 2013, both varieties have

formed the most productive stem's stability and thickness by plating on September 30th – 665 pcs./m² (Odesyka Misiya) and 661 pcs./m² (Table 3).

Table 3 – **Number of productive stems of winter varieties, depending on the terms of sowing of wheat in the research years**, pcs./m²

Variety (factor A)	Sowing dates (factor B)								
	20.09			30.09			10.10		
	2013	2014	2015	2013	2014	2015	2013	2014	2015
Odesyka Misiya	651	873	825	665	997	893	659	961	614
Ovidiy	647	658	650	661	959	936	655	822	512

Grades Odesyka Misiya and Ovidiy formed the largest number of productive stems (997 and 959 pcs./m²) which were sown on September 30th, 2014.

The lower productivity of stalks (614 pcs./m²) was shown by the Odesyka Misiya and (512 pcs./m²) by the Ovidiy in 2015 when it was sown on October 10th.

Grades Odesyka Misiya and Ovidiy formed the largest number of productive stems (997 and 959 pcs./m²) in 2014 when they were sown on September 30th. The lower productivity of stalks (614 pcs./m² on the variety of Odesyka Misiya and 512 pcs./m² for a variety Ovidiy) formed investigated varieties in 2015 by the time of sowing on October 10th.

It is known that higher temperatures in the later stages of winter wheat growing season lead to large losses of grain (20.4%) compared with the earlier (15.5%).

Our research has shown that the most favorable weather conditions during the period of «heading - milky ripeness» of winter wheat were in 2013, on the time of sowing on October 10th. During this period there were 52 mm of rain sediments, the average temperature was 20,1 °C, which influenced the process of fertilization, ripening and grain's size.

Yields of wheat which were sown in the period (October 10 th) was higher, it was 5.54 t / ha (Odesyka Misiya) and 4.92 t/ha (Ovidiy). Sowing which was done on September 20th and 30th in the period of «heading - milky ripeness» was just 13 mm, and the yield of wheat was formed at the level 4,37-5,23 t/ha (Table 4).

Table 4 – **Yields of winter wheat varieties depending on the sowing date and weather conditions during the period of «heading - milky ripeness»,** t/ha

Variety (factor A)	Sowing dates	Years								
		2013			2014			2015		
		Average t ° C	Rainfall sedments in mm	Yield, t/ha	Average t °C	Rainfall in mm	Yiel, t/ha	Average t ° C	Rainfall sedments in mm	Yield, t/ha
Odesyka Misiya	20.09	20,3	13	4,92	18,9	33	5,62	20,4	20	5,48
	30.09	20,3	13	5,23	20,1	25	6,05	20,6	20	6,40
	10.10	20,1	52	5,54	20,9	16	6,26	20,8	20	4,51
Ovidiy	20.09	20,3	13	4,37	18,9	33	5,15	20,4	20	5,25
	30.09	20,3	13	4,51	20,1	25	5,67	20,6	20	6,11
	10.10	20,1	52	4,92	20,9	16	5,82	20,8	20	4,26

In 2014, the most favorable conditions for grain formation can be explained by the greater moisture supply of crops, as heading before, during and after 74 mm of rain sediments the average temperature in this case was 20.9 °C.

In 2015, weather conditions in the period of "heading - milky ripeness" at all stages of crop's development was almost identical. The maximum yield was observed by the sowing plated on September 30th and was the grades of 6.40 t / ha (Odeska Missiya) and 6.11 t/ha (Ovidiy). This can be explained by a high coefficient of tillering plants, therefore, a large number of productive stems per 1 m². The crops of the third period (on October 10 th) through early termination of the autumn season growing showed less productive stems.

Conclusions. According to our studies it was found that the sowing time and the weather in spring-summer period have a significant effect on the length of phases of «the resumption of vegetation» and «heading», plant's height, number of productive stems per 1 m², formation of productivity of varieties of winter wheat.

The most prolonged (82-88 days) interphase period «the renewal of spring tillering-heading» was in 2015, when the sum of effective temperatures was 356,3-454,4 °C and sediments 153 mm.

Plant height had decreased from early to late sowing dates in the average grades of 7.4 cm. The most favorable for the growth and development of winter wheat were the weather conditions in 2014, when the height of the plants of studied varieties reached the average 75.2 cm (Ovidiy) for the time of sowing and 75.8 cm (Odesyka Misiya).

Under the conditions of the South Steppe of Ukraine the optimum sowing period of winter wheat varieties Odesyka Misiya and Ovidiy on the forecrops fallow should be considered as the period from the 30th of September to the 10th of October, which is formed by 655-997 pcs. / m² of productive stems and grain yield at the level of 4, 92-6,40 t/ha.

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Продуктивность сортов пшеницы мягкой озимой в зависимости от сроков сева и погодных условий весенне-летнего периода

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Изучено влияние сроков сева и погодных условий весенне-летнего периода на формирование продуктивности современных сортов пшеницы озимой в условиях Южной Степи Украины. Установлено, что основную роль в формировании продуктивности этой культуры в весенне-летний период играет продолжительность межфазного периода «возобновление весеннего кущения – колошение», который был самым коротким (64-65 суток) в 2013 году, сумма эффективных температур при этом составила 390,4-406,0 °С, а самым длинным (82-88 суток) – в 2015 году, что обусловлено лучшими погодными условиями во время вегетации. Высота растений озимой пшеницы снижалась с ранних до поздних сроков сева в среднем по сортам на 7,4 см. Наилучшие условия для роста и развития растений пшеницы озимой сложились в 2014 году, когда высота растений исследуемых сортов достигала в среднем по срокам сева 75,2 см (Овидий) и 75,8 см (Миссия одесская). Исследуемые сорта пшеницы озимой сформировали наибольшее количество продуктивных стеблей (997 и 959 шт./м²) в 2014 году при посеве 30 сентября. Самый низкий продуктивный стеблестой (512-614 шт./м²) сформировали исследуемые сорта в 2015 году при посеве 10 октября. Исследованиями установлено, что оптимальные погодные условия в период «колошение – молочная спелость зерна» пшеницы озимой были в 2013 году при посеве 10 октября. Самая высокая урожайность зерна пшеницы озимой (6,40 т/га) сформировалась в 2015 году при посеве сортом Миссия одесская в срок 30 сентября. В 2013-2014 годах самый высокий урожай зерна изучаемых сортов был собран при посеве 10 октября, что на 0,15-0,41 т/га превысило контроль – 30 сентября.

Ключевые слова: пшеница озимая, сорт, сроки сева, количество продуктивных стеблей, высота растений, урожайность.

Productivity of soft winter wheat sort depending on terms length of sowing and weather in spring-summer period

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The article is about influence of sowing terms and weather conditions in spring-summer period on the productivity’s formation of the winter wheat modern varieties in conditions of the South Steppe of Ukraine. It was faund that spring-summer period the main role in formation of crop productivity wasplayed by the length of “renewal of spring tillering-heading” phases, the shortest of which (64-65 days) was in 2013, the sum of effective temperatures thus amounted to 390,4-406,0 °C, and the longest (82-88 days) was in 2015, due to the best weather conditions during the growing season. Plant’s height of winter wheat decreased from early to late sowing terms on the average in of different varieties to 7,4 cm. The best conditions for the growth and development of winter wheat plants were in 2014, when the plant height of the studied varieties reached on the average 75.2 cm (Ovidiy) and 75.8 cm (Odesyka Misiya). The examined winter wheat varieties formed the largest number of productive stems (997 and 959 pcs./m²)) in 2014 by sowing on September 30. The lowest productive stubble (512-614 pcs./m²) was formed by the studied sorts in 2015 by sowing on October 10. The researches have faund that the best weather conditions during the period of "renewal of spring tillering-earing" of winter wheat were in 2013 by sowing on October 10. The highest grain yield of winter wheat (6.40 t/hectares) was formed in 2015 by the sowing of the Odesyka Misiya on September 30. In 2013-2014, the highest yield of the studied grain sorts was collected by sowing on October 10, which was 0.15-0.41 t/ha more than the control – September 30.

Key words: winter wheat, sort, sowing, number of productive stems, plant height, crop yields.

Надійшла 10.04.2018 р.