Plant Cell Biotechnology and Molecular Biology 21(63&64):31-37; 2020 ISSN: 0972-2025

FORMATION OF HARD SPRING WHEAT PRODUCTIVITY DEPENDING ON THE MINERAL FERTILIZERS AND BIOLOGOCAL PREPARATIONS

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Article Information

Editor(s):
(1) Dr. Seema Akbar, University of Kashmir, India.
Reviewers:
(1) Alapati Anitha, Sri Venkateswara Veterinary University, India.
(2) Rachmawati Hasid, University of Halu Oleo, Indonesia.

Received: 22 September 2020
Accepted: 27 November 2020
Published: 10 December 2020

Original Research Article

ABSTRACT

Introduction: In the conditions of unstable and insufficient moisture, it is necessary to study the basic elements of the technology of growing hard spring wheat in the context of climate changes.
Methods: Field, laboratory, evaluation and comparison.
Results: The complex study and analysis of the application of microbiological biological preparations depending on the background of mineral nutrition in the technologies of growing hard spring wheat were carried out. The formation of the leaf surface of plants depended both on the background of mineral nutrition and on the application of microbiological preparations. On non-fertilized areas, seed treatment with biopreparations increased the area of the leaf surface by 20.3% for the use of polymyxacarbonate, 20.5% for diazophyte and 23.9% for the mixture of these two preparations. For fertilizers $N_{45}R_{45}K_{30}$ it amounted to 31.9 thousand m^2 / ha, the use of polymicobacterin resulted in an increase of 19.1%, diazophyte - by 13.8%, a mixture of preparations - by 24.1%. The fertilized background of \"straw N_{10} per ton of by-products\" was effective, as the area of the leaf surface was quite large (29.2 thousand m^2 / ha), and with the usage of biopreparations, respectively, 33.9; 32.9; 36.4 thousand m^2 / ha. The yield of hard spring wheat is determined by the number of productive stems per unit area and the weight of grain from one ear. The yield was the largest in areas planted with inoculated seeds by polymicobacterium and diazophyte on the fertilizer background $N_{45}R_{45}K_{30}$ - 3.50 t / ha, which is 1.47 t / hectares (72.4%) more than in the plots without mineral fertilizers and biopreparations (2.03 t / ha). A rational way to increase the yield of hard spring wheat is to apply fertilizer \"N_{10} straw per ton of by-products\" with the obligatory treatment of seeds before sowing with a mixture of biological products, the yield of grain was 3.16 t / ha, which is 1.13 t / ha (55.7%) higher than for non-fertilized cultivation.
Conclusions: In conditions of unstable moisture with the technology of growing hard spring wheat, it is necessary to apply pre-sowing seed treatment with preparation of diazophyte and polymicobacterin on the background of straw predecessor, after its gathering, the necessarily application of N_{10} per ton of by-products, which will ensure the yield 3.16 t / ha of wheat grain. In

the absence of by-products of the predecessor on the field, the pre-sowing seed treatment with preparation of diazophyte and polymicobacterin with the necessarily application of $N_{45}R_{45}K_{30}$ should be used, which will provide grain yield of wheat at 3.50 t / ha.

Keywords: Hard spring wheat; mineral fertilizers; diazophyte; polymicobacterin.

INTRODUCTION

Over the past few years the climate changes have become evident in the Left-Bank of the forest-steppe region of Ukraine. The spring period is often accompanied by drought and air storms. The precipitation falls unevenly in the spring, which is characteristic of the zone of unstable moisture. Summer months are accompanied by severe drought, which is often on the phase of grain pouring of early grain crops and reduces their yield. In such conditions, it is necessary to study the basic elements of the technology of growing hard spring wheat in the context of climate changes**.**

High productivity and quality of grain are achieved at full supply of plants with nutritional elements and other factors at all stages of plant growth and development [1-2,3]. Taking into account the methods that have a positive or negative effect on yield, it is possible to reduce significantly the negative effects of meteorological conditions and to use purposefully the elements of cultivating technology that can be controlled by humans [4,5].

In the system of measures aimed at the cultivation and production of spring wheat, the use of chemical and biological means in cultivation technologies is important because they contribute to a significant increase in its productivity [6-8]. At the same time, different ways to increase the efficiency of wheat growing technologies were developed and applied [3]. Some of them have lost their significance, or they do not meet the current scientific requirements, or they do not provide the required yield and quality of products. The development of modern fertilizer systems for wheat involves full satisfaction of plants needs in the elements of mineral nutrition. Solving this problem only through the use of expensive mineral fertilizers often reduces the competitiveness of grain production of hard wheat varieties [9,10]. In recent years microbiological preparations of soil bacteria have been created and industrially produced, which can significantly improve the maintenance of micro-elements of cultivated plants [11-12].

In this connection, it is necessary to carry out a comprehensive study and analysis of the usage of microbiological biological preparations depending on the background of mineral nutrition in cultivation technologies, to establish their effectiveness in order to improve the quality of grain, to determine the directions and prospects for development, both scientific research and practical application in production.

MATERIALS AND METHODS

The purpose of our researches was to establish the rules for the introduction of mineral fertilizers, provided by the use of biopreparations that contribute to optimal development of aboveground and underground parts of plants and ensure the formation of a stable high yield of high quality grain, despite the weather conditions.

The tasks of the research are to study the peculiarities of growth, the development of plants with the usage of pre-seed treatment of seeds with different biological preparations depending on the level of mineral nutrition and to establish their optimal ratio to ensure the formation of stable yield of hard spring wheat grain with high qualitative characteristics.

The main researches were carried out on the research field of Poltava Institute of Agricultural Production after M.I. Vavilov in 2013-2015. The effect of pre-sowing treatment of seeds by microbiological preparations depending on the balance method of the mineral nutrition of plants for the yield of 3 t/ha of grain was studied. Six mineral nutrient backgrounds were studied: no fertilizers - control; N_{45}; $P_{45}K_{30}$; $N_{45}P_{45}K30$; $N_{23}P_{23}K_{15}$; straw predecessor N_{10} for every ton of by-products. The main methods of the research were: field method is the study of the interaction of the subject of research with the agronomic factors; calculation and weighting method is setting parameters indicators of grain yield and its structure; laboratory method is determination of biometric indices and productivity of plants.

The weather conditions in different years of research were characterized by great diversity. The winter period was prolonged with intense thaws, with the increasing the maximum temperature in some years to 12-14ºC warmth. The characteristic feature of the temperature of the winter period was relatively small fluctuations in the context of months. For the summer period, high and steady temperatures were characteristic. In the warmest month July, the average temperature was between 18-20ºC. The temperature of August was varied by 1-2ºC. Absolute maxima were 37-39ºC. The greatest decreasing in temperature was observed during October-November. The transition to average minus temperatures in autumn was in mid-November.

The duration of the period with an average daily temperature of more than 5ºC was within 200-210 days. The transition of temperature through this boundary in the spring was during the first decade of April, and in the autumn was in the third decade of October. The last spring frosts in the air were sometimes observed in the second half of May, and the first autumn one is in September.

The period of active vegetation with a steady rise in temperature above 10°C began in the third decade of April with slight fluctuations in some years within 5-10 days. The end of this period coincided with the beginning of the first autumn frosts in the air (the first decade of October). The duration of the active vegetation period was from 157 to 169 days.

The beginning of the period of intensive vegetation with the onset of the average daily temperature above 15ºC was observed in the middle or at the end of May. The duration of this period is 100-120 days. The distribution of precipitation during the growing season was uneven. The amount of precipitation in some years varied from 320 to 829 mm.

RESULTS AND DISCUSSION

Our studies have shown that the arid weather conditions of the second half of the vegetation, contributed to a significant reduction in planting. The density of plants did not depend on the action of mineral fertilizers and biopreparations. Application of mineral fertilizers and inoculation of spring wheat seeds by biopreparations positively influenced the growth and development of plants (Fig. 1). In the earing phase, the height of wheat plants without using the fertilizers and inoculation was 56.7 cm, with the usage of polymicobacterium, this figure was increased to 65.8 cm, diazophyte - up to 68.9 cm, with their consistent application - up to 63.9 cm. When applying mineral fertilizers in a dose $N_{45}P_{45}K_{30}$ plant height increased to 62.5 cm without inoculation. With the combined action of fertilizers and biomaterials, this figure was within the range of 71.7-73.6 cm. When the fertilizer dose was halved ($N_{23}P_{23}K_{15}$), the plant height without inoculation was 62.0 cm, while the seeds were treated with microbial preparations - 66.6-70.5 cm. The results of the correlation analysis showed that biopreparations increased the plant height by 15.9% (polymicobacterium), 17.0% (diazophyte) and 13.2% (compatible application of two preparations). As for mineral fertilizers, the maximum increasing of the height of the wheat plants was at fertilization $N_{45}P_{45}K_{30}$ – 9.9%. So, biologicals have much greater effect on the height of the plants of spring hard wheat than mineral fertilizers.

More significant influence on the size of the leaf surface was exercised by these means. In the ear phase, the area of the leaf surface with the usage of biopreparations was 30.5-31.7, without inoculation - 25.9 thousand m² / ha. When using biological agents on the background of mineral fertilizers $N_{45}R_{45}K_{30}$, this figure increased to 34.3-38.0, without inoculation - up to 29.4 thousand m² / ha. Other fertilizer options were also quite effective: on the background of nitrogen fertilizers, the best effect for the growth of the leaf surface was diazophyte, on the background of phosphoric-potassium fertilizers – polymicobacterium.

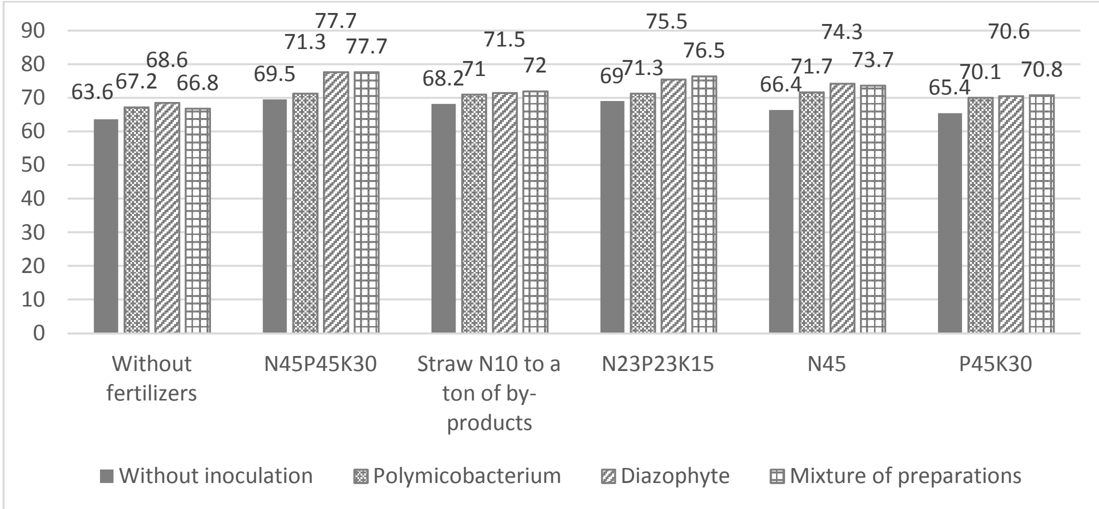

Fig. 1. The height of plants of spring wheat, depending on the effect of mineral fertilizers and biomaterials, cm (2013-2015)

The specific proportion of biological preparations and the fertilizer background on the area of the leaf surface of hard spring wheat were defined in order to determine the influence of technological measures (Figs. 2-3). The mathematical analysis carried out on all variants of the experiment made it possible to establish that the area of leaves without using inoculation with biological preparations was 28.3 thousand m^2/ha. The inoculation of the seeds by polymicobacterin contributed to increase of this index to 32.8, diazophyte to 33.1, a mixture of preparations to 34.7 thousand m^2 / ha. As for the background of mineral nutrition, the area of the leaf surface has the following values: without fertilizers it was 29.2 thousand m^2/ha; $N_{45}R_{45}K_{30}$ - 36.5 thousand m^2/ha, or increased by 25.0 %; straw N_{10} per ton of by-products - 33.1 thousand m^2/ha, or increased by 13.4 %; $N_{23}R_{23}K_{15}$ - 31.8 thousand m^2/ha, or increased by 8.9%; N_{45} - 31.8 thousand m^2/ha, or increased by 8.9 %; $P_{45}K_{30}$ - 31.2 thousand m^2/ha, or increased by 3.5%.

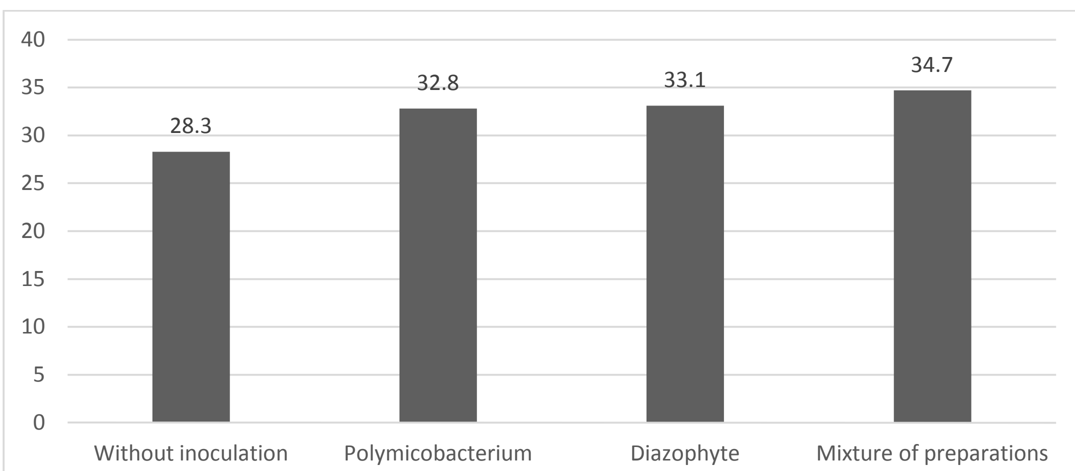

Fig. 2. The area of the leaf surface of hard spring wheat, depending on the effect of grain inoculation with biopreparations, thousands m^2 / ha (2013-2015)

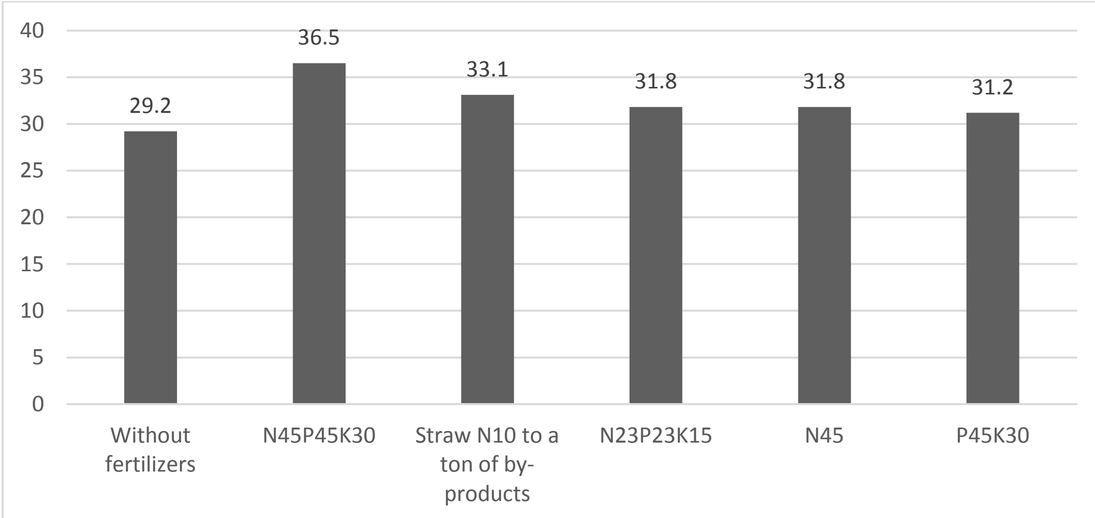

Fig. 3. The area of the leaf surface of hard spring wheat, depending on the influence of different fertilizer backgrounds, thousands m^2 / ha (2013-2015)

Table 1. The yields of hard spring wheat depending on the effect of mineral fertilizers and biopreparations (average for 2013-2015), t/ha

Variants of fertilization	Variants of inoculation	Grain yield, t/ha	Increase, t/ha		
			from mineral fertilizers	from the biological preparations	from mineral fertilizers and the biological preparations
Without fertilizers	Without inoculation	2,03	-	-	-
	Polymicobacterium	2,54	-	+0,51	-
	Diazophyte	2,35	-	+0,32	-
	Mixture of preparations	2,62	-	+0,59	-
$N_{45}P_{45}K_{30}$	Without inoculation	2,68	+0,65	-	-
	Polymicobacterium	3,27	-	+0,59	+1,24
	Diazophyte	3,08	-	+0,40	+1,05
	Mixture of preparations	3,50	-	+0,82	+1,47
Straw N_{10} to a ton of by-products	Without inoculation	2,50	+0,47	-	-
	Polymicobacterium	2,94	-	+0,44	+0,91
	Diazophyte	2,86	-	+0,36	+0,83
	Mixture of preparations	3,16	-	+0,66	+1,13
$N_{23}P_{23}K_{15}$	Without inoculation	2,48	+0,45	-	-
	Polymicobacterium	2,81	-	+0,33	0,78
	Diazophyte	2,57	-	+0,09	+0,54
	Mixture of preparations	2,53	-	+0,05	+0,50
N_{45}	Without inoculation	2,37	+0,34	-	-
	Polymicobacterium	2,57	-	+0,20	+0,54
	Diazophyte	2,98	-	+0,61	+0,95
	Mixture of preparations	2,98	-	+0,61	+0,95
$P_{45}K_{30}$	Without inoculation	2,27	+0,24	-	-
	Polymicobacterium	2,53	-	+0,26	+0,50
	Diazophyte	2,94	-	+0,67	+0,91
	Mixture of preparations	2,69	-	+0,42	+0,66

HIP_{05} (fertilization), t/ha 2010 – 0,08; 2011 – 0,07; 2012 – 0,06.
HIP_{05} (biological preparations), t/ha 2010 – 0,06; 2011 – 0,11; 2012 – 0,07.
HIP_{05} (interaction), t/ha 2010 – 0,09; 2011 – 0,10; 2012 – 0,09

In the non-fertilizer background, without inoculation with biopreparations (control), wheat grain yield was 2.03 t/ha, in areas with polymicobacterium - 2.54 t/ha, diazophyte - 2.35, mixture of preparations - 2.62 t/ha (Table 1). At sites with the application of $N_{45}R_{45}K_{30}$ (without inoculation preparations) it was 2.68 t / ha, with the usage of polymicobacterium - 3.27, diazophyte - 3.08, mixture of preparations - 3.50 t/ha. At the sites of the \"straw N_{10} per ton of by-products\" variant (without inoculation by preparations) it was 2.50 t/ha, for the usage of polymicobacterium - 2.94, diazophyte - 2.86, mixture of preparations - 3.16 t/ha. At sites with the application of $N_{23}R_{23}K_{15}$ (without inoculation preparations) it was 2.48 t/ha, for usage of polymicobacterium - 2.81, diazophyte - 2.57, mixture of preparations - 2.53 t/ha. At sites with the application of N_{45} (without inoculation by preparations) it was 2,37 t/ha, for usage of polymicobacterium - 2,57, diazophyte - 2,98, mixture of preparations - 2,98 t/ha. At sites with the addition of $P_{45}K_{30}$ (without inoculation preparations) it was 2.27 t/ha, for the usage of polymicobacterium - 2.53, diazophyte - 2.94, mixture of preparations - 2.69 t/ha. The increase in grain yield from mineral fertilizers was as follows: for using $N_{45}R_{45}K_{30}$ it was 0.65 t/ha (32.0%), \"straw N_{10} per ton of by-products\" - 0.47 t/ha (23.2%), $N_{23}R_{23}K_{15}$ - 0.45 t/ha (22.2%), N_{45} - 0.34 t/ha (16.7%), $P_{45}K_{30}$ - 0.24 t/ha (11.8%).

On the non-fertilizer background, the increase in the usage of polymicobacterium amounted to 0.51 t/ha (25.1%), diazophyte - 0.32 (15.8), mixture of preparations - 0.59 (29.1%). On the fertilized backgrounds, with the usage of polymico bacterium, respectively fertilized variants: $N_{45}R_{45}K_{30}$ - 0,59 t/ha (22,1%), \"straw N_{10} per ton of by-products\" - 0,44 t/ha (17,6%), $N_{23}R_{23}K_{15}$ - 0.33 t/ha (13.3%), N_{45} - 0.20 t/ha (8.4%), $P_{45}K_{30}$ - 0.26 t/ha (11.5%). On fertilized backgrounds, with the usage of diazophite, respectively fertilized variants: $N_{45}R_{45}K_{30}$ - 0.40 t / ha (14.9%), \"straw N_{10} per ton of by-products\" - 0.36 t/ha (14.4%), $N_{23}R_{23}K_{15}$ - 0.09 t/ha (3.6%), N_{45} - 0.61 t/ha (25.7%), $P_{45}K_{30}$ - 0.67 t/ha (29.5%). On fertilized backgrounds, with the usage of the mixture of polymicobacterium and diazophyte, respectively fertilized variants: $N_{45}R_{45}K_{30}$ - 0.82 t/ha (30.6%), \"straw N_{10} per ton of by-products\" - 0.66 t/ha (26.4%), $N_{23}R_{23}K_{15}$ - 0.05 t/ha (2.0%), N_{45} - 0.61 t/ha (25.7%), P_{45}K30 - 0.42 t/ha (18.5%).

CONCLUSIONS

The formation of the leaf surface of hard spring wheat depended both on the background of mineral nutrition and on the application of microbiological preparations. On non-fertilized areas, seed treatment with biopreparations increased the area of the leaf surface by 20.3% with the usage of polymyxacarbonate, 20.5% with diazophyte and 23.9% with the mixture of these two preparations. For application of fertilizers $N_{45}R_{45}K_{30}$ it amounted to 31.9 thousand m^2/ha, the usage of polymicobacterin resulted in increasing to 19.1%, diazophyte - by 13.8%, a mixture of preparations - by 24.1%. The fertilized background of \"straw N_{10} per ton of by-products\" was effective, as the area of the leaf surface was quite large (29.2 thousand m^2/ha), and with the usage of biological products, respectively, 33.9; 32.9; 36.4 thousand m^2/ha.

The yield of hard spring wheat was determined by the number of productive stems per unit area and the weight of grain from one ear. It was the largest in areas planted with inoculated seeds by polymicobacterium and diazophyte on the fertilizer background $N_{45}R_{45}K_{30}$ - 3.50 t/ha, which is 1.47 t/hectares (72.4%) more than in the sites without mineral fertilizers and biopreparations (2.03 t/ha).

In conditions of unstable moisture with the technology of growing hard spring wheat, it is necessary to apply pre-sowing seed treatment with preparation of diazophyte and polymico bacterin on the background of straw predecessor, after its gathering, the necessarily application of N_{10} per ton of by-products, which will ensure the yield 3.16 t/ha of wheat grain. In the absence of by-products of the predecessor on the field, the pre-sowing seed treatment with preparation of diazophyte and polymicobacterin with the necessarily application of $N_{45}R_{45}K_{30}$ should be used, which will provide grain yield of wheat at 3.50 t/ha.

COMPETING INTERESTS

Authors have declared that no competing interests exits.

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