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IMPACT OF METHODS OF SOIL CULTIVATION AND TIMING OF FERTILIZATION ON INCREASING THE DROUGHT RESISTANCE OF WINTER WHEAT IN NATURAL CONDITIONS

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Abstract

In order to mitigate the decline and loss of crop yields due to the deterioration of ecological conditions, the impact of methods of soil tillage and fertilization on regulation of water regime and increase of drought resistance of winter wheat was studied in the brown gravel soils of the lowland zone of Martuni region in the conditions of rainfed agriculture.

The advantage of the zero tillage over the improvement of water properties of soil compared to the traditional tillage was revealed by experimental-research method and also the positive effect of phosphorus-potassium fertilizers and the negative impact of nitrogen and complete fertilizers used before tillage on such physiological property which provides drought tolerance of wheat plants as the decrease of intensity of transpiration was found out. At the same time, it turned out that phosphorus-potassium fertilizers given before sowing and nitrogen fertilizer given in the spring as nutrient create a equal balance of nutrients in plants,

xerophyte traits are developed in plants and high crop yield is obtained in the conditions of high tension of atmospheric factors.

Key words: tillage with furrow turn, zero tillage, field humidity, fertilizing period, transpiration intensity, whaet yield.

Introduction

Edward Faulkner, the founder of US Rehabilitation Agriculture, expressed an idea about the water regime of the soil, that the water regimes in the cultivated and uncultivated lands are completely different. According to Faulkner, the surface of uncultivated soils is covered with a protective layer of plant debris and linear connection from underground water to soil surface is provided, but in cultivated lands tillage interrupts this connection and soil simply stops working until irrigation is renovated. The top layer of untreated soil, rich in organic matter, involves many factors contributing to plant growth in the soil process. It accumulates and retains several times more water in its entire volume than the clay-sand particles that make up the inorganic part of the soil which retain water only on their surface. In addition, the top layer collects and retains groundwater, which allows plants to withstand even prolonged drought. The topsoil moisture not only satisfies the need of plants for water but also promotes the decomposition of organic matter. Thus, the water in the soil is enriched with secondary nutrients, and the water in the subsoil absorbed by the same soil enriches it with primary elements [1].

The founder of Russian agriculture I.E. Ovinsky emphasized the concept of atmospheric irrigation in regulating the water regime of the soil, according to which the soil can condense a significant amount of air moisture, a large amount of gases and dust due to differences in the temperature of the deep layers of the soil and atmosphere. According to Ovinsky, the first condition for atmospheric irrigation should be the porosity of the soil, that is, all its naturally formed pores and holes should be preserved, second, the soil temperature should be lower than air temperature, and third, the soil moisture should be preserved at great depths, this moisture can only be effective when rising through undamaged vessels to warmer upper layers of the soil creating favorable conditions for the growth of bacteria living there which fix free nitrogen in the atmosphere. According to this statement, deep tillage is twice harmful. First, it leaves bacteria there where they can not live, and on the other hand, it destroys the natural porosity of soils, which inhibits both atmospheric irrigation and the activity of nitrifying and nitrogen-fixing bacteria. And 5 cm deep surface loosening is a good guarantee for nitrification and atmospheric irrigation, because in such cultivation the soil is constantly subject to ventilation, its temperature in the lower layers is always so low that atmospheric irrigation takes place very actively, the soil retains its capillary system as a result of which the moisture rises to the upper warm layers promoting the vital active activity of nitrifying bacteria and seed germination [2].

As a result of the research carried out in the conditions of the irregular wetting zone of Stavropol region (2015), L.A. Petrova and others came to the conclusion that the moisture used by plants for crop yield, is better accumulated and stored in the zero crop cultivation system than in the case of sowing with traditional technology [3].

According to the researchers, cultivation from the driest steppes to the non black soil zone improves the water supply of crops and prevents soil drought which is due to the continuous wing tillage that causes agrophysical degradation of the soil [4, 5, 6].

An important agronomic measure to fight drought is the correct definition of the time of the inserting of various mineral fertilizers into the soil.

The role of fertilizers in the fight for high yields of crops has long been known. However, the problem of reducing the destructive effects of external adverse factors with the help of fertilizers was mentioned only in the second half of the 19th century.

K.A. Timiryazev pointed out that among the external influences with which a person can reduce the inefficient consumption of water by plants, he first of all refers to the use of fertilizers in his famous lecture "Plant Fight against Drought" in 1882 [7].

Due to the increase in the amount of colloidal water and the increase in plasma viscosity, phosphorus increases the water retention capacity of the protoplasm.

The positive effect of potassium on the water regime and drought resistance of wheat plants is emphasized in the work of a number of researchers.

Many researchers believe that potassium increases the water retention capacity of plasma colloids, reduces transpiration and increases the amount of water. Nitrogen fertilizers applied to the soil before sowing promote the development of mesophytic properties in plants, which significantly reduces their resistance to unfavorable external conditions [8, 9, 10].

Conflict setting

In a zone of insufficient moisture such as our republic, the problem of regulating the water regime of sowing is the accumulation, storage and effective use of soil moisture. In such conditions, the problems of protection of soil moisture and drought control should be solved together with the fight against wind and water erosion in one complex using soil protection agro-technologies, special equipment for its implementation, reclamation, forest reclamation and other measures giving special place to recently widely adopted free, minimal tand zero soil cultivation.

Based on the above mentioned, we have set a task to find out the impact of mineral fertilizer and time of its introduction dates, the main methods of soil cultivation, effective accumulation of soil moisture, its storage, increase of plant drought resistance and finally increase of crop yield of winter wheat through experimental research.

Material and method

Researches have been carried out in two stages: a. field experiments and b. laboratory studies in 2018-2020 at the Chair of Agronomy of Shushi University of Technology.Field experiments were conducted in lowland soils of Martuni region in brown, sometimes limed, gravel and medium strong soils with three repetitions. The total surface of rows comprised 120m^2 and calculated one was 100 m^2. We used the "Krasnodarskaya99" sort of wheat for studies. The following variants were studied:

1. Traditional tillage without fertilizing (testing)
2. $P_{90}K_{60}$ before tillage
3. N_{90} before tillage
4. $P_{90}K_{60}N_{90}$ before tillage
5. $P_{90}K_{60}$ before tillage, N_{90} in spring
6. Mimimal tillage without fertilizing
7. $P_{90}K_{60}$ before tillage
8. N_{90} before tillage

9. $P_{90}K_{60}N_{90}$ before tillage
10. $P_{90}K_{60}$ before tillage, N_{90} in spring as nutrient

In all the years of the research the winter crop was the previous one. The soil is traditionally prepared for sowing according to the agricultural techniques used in the region. After the previous harvest, the stubble was cut with a BDN disk rake (3-5 cm). 3-4 weeks later the field was plowed with PN -4-35 plow of 22-25 cm. The soil was prepared for the minimal sowing in the same time. After surface tillage of the stubble surface tillage of the soil was performed with a (8-10 cm) АБД4х2ПГ disk plow instead of tillage of furrow turn. The fertilizers, according to the experimental scheme, were introduced into the soil during the main cultivation. Nitrogen feeding was done in early spring. Double superphosphate was used as phosphate fertilizer, potassium chloride was used as potassium fertilizer and ammonia nitrate was used as nitrogen. Pre-sowing cultivation and sowing were carried out in mid-November with a КПС-4Г fallow cultivator and СЗУ-3,6 rowing.

Moving nutrients were identified in the 0-15 cm layer of soil before experimenting each year. According to the data obtained, in all the years of experimentation, before fertilizing the soil, the soil of the experimental site was well supplied with only potassium and nitrogen and weakly supplied with phosphorus. Plants were counted during the vegetation period to study field germination, winter resistance, general and effective bushing. Phenological observations and biometric measurements were made during the vegetation. Field soil moisture at different stages of plant development was determined by gravimetric method and transpiration intensity was determined by Ivanov gravimetric method [1]. The grain yield was determined by the method of harvesting and weighing the yield of each variety and replication with a combine. Yield data were subjected to mathematical processing by dispersion analysis.

Reaearch results

The data of dynamics of the change of moisture amount in tillage layer depending on the method of cultivation and time of fertilization are given in Table 1.

Table 1

The data of dynamics of the change of moisture amount in tillage layer (%) depending on the method of cultivation and time of fertilization (average for 2018-2020)

N	Variants	Before sowing	Bushing, tubing	Stalking	Ripening	Before harvesting	Average
1	Traditional tilliage without fertilization (T)	21,35	25,6	25,81	23,64	18,3	22,94
2	$P_{90}K_{60}$	21,42	25,62	26,14	24,19	19,49	23,37
3	N_{90}	21,79	25,71	25,14	23,11	18	22,75
4	$P_{90}K_{60}$ N_{90}	21,34	25,82	25,93	23,94	18,7	23,14
5	$P_{90}K_{60} + N_{90}$	21,4	26,12	26,17	24,23	18,94	23,37
6	Minimal tillage without fertilizing (T)	22,49	27,34	28,12	27,14	20,41	25,10
7	$P_{90}K_{60}$	22,68	28,15	28,62	28,21	22,14	25,96
8	N_{90}	22,74	26,56	27,03	26,45	20	24,55
9	$P_{90}K_{60}$ N_{90}	22,81	27,92	27,45	27,63	21,33	25,42
10	$P_{90}K_{60} + N_{90}$	22,4	28,31	27,74	28,09	22,65	25,83

According to the data obtained, the moisture content of the arable layer depends on both the method of soil cultivation and the timing of application of soil fertilizer. Most of the moisture in the topsoil was accumulated during the minimum tillage options. However, according to the data in the same table, the timing of application of fertilizers into the soil had a significant impact on the accumulation and storage of moisture. If in the case of phosphorus-potassium fertilizers applied to the soil before the minimum tillage and sowing the moisture accumulated in the arable layer was 25.96%, then in the versions with only nitrogen or complete NPK fertilizers before sowing on the same background, the same index was 24, 55 and 25.42% respectively. On the other hand, 25.83% of water in average was accumulated in the arable land in the version fed with nitrogen fertilizer in the spring and with only phosphorus-potassium before sowing.The same pattern has been observed in traditional tillage options.

It can be seen from Table 2 that the wet-dry weights of the first level leaves of the plants calculated from the spike, increase under the influence of fertilizers compared to the controller. The plants with the highest wet weight were those that received phosphorus-potassium fertilizers before sowing, and nitrogen fertilized were those that received it as nutrient in spring.

The total water content decreased to some extent only in those leaves of the plants of type 2 which received phosphorus-potassium fertilizer before sowing compared to the tester, while in other varieties, especially in those where nitrogen fertilizer was applied separately or in combination with phosphorus-potassium fertilizer in autumn before sowing, it increased.The results of the transpiration study show that, in addition to option 2, fertilizers have increased the intensity of transpiration. This can be partially explained by the fact that the total amount of water in plants with a mesophytic structure of leaves increases compared to other variants.

Table 2

The impact of fertilization time and methods of soil tillage on some properties of water regime of laves of winter wheat (average for 2018-2020)

N	Variants	Weight of 10 leaves (g)		Water amount (%)		Intensity of transpiration
		Wet	Dry	According to wet mass	According to dry mass	
1	Traditional tilliage without fertilization (T)	3,842	1,324	65,54	190,18	1,651
2	$P_{90}K_{60}$	3,867	1,39	64,05	178,2	1,468
3	N_{90}	4,891	1,261	74,21	287,81	2,084
4	$P_{90}K_{60}N_{90}$	4,926	1,427	71,03	245,18	1,892
5	$P_{90}K_{60} + N_{90}$	4,993	1,694	66,07	194,71	1,554
6	Minimal tillage without fertilizing (T)	2,956	1,183	59,98	149,87	2,126
7	$P_{90}K_{60}$	3,712	1,491	59,83	148,93	2,052
8	N_{90}	7,125	2,601	63,49	173,93	2,372
9	$P_{90}K_{60}N_{90}$	4,634	1,661	64,14	178,85	2,373
10	$P_{90}K_{60} + N_{90}$	5,126	1,987	61,23	157,96	2,149

Soil cultivation methods and targeted use of mineral fertilizers play an important role in the complex of other measures to achieve a high and stable yield of winter crops.

The definition of optimal fertilization dates not only ensures a stable growth of the crop, but also contributes to the improvement of the quality of the produced products.

This is evidenced by the winter wheat grain yield and crop quality data we received which are presented in Table 3.

Table 3

Yield of winter wheat and the amount of gluten in a grain depending on the methods of soil cultivation and fertilization time

Variants	Crop yield, c/hectare	Supplementing to tester		Gluten outcome c/hectare	Supplementing to tester	
		c/hectare	%		c/hectare	%
Background – traditional tillage without fertilizing (T)	18,7	-	100	3,92	-	100
$P_{90}K_{60}$	19,9	1,2	6,4	4,17	0,25	6,37
N_{90}	20,3	1,6	8,5	4,46	0,54	13,77
$P_{90}K_{60}N_{90}$	25,8	7,1	37,9	5,80	1,88	47,95
$P_{90}K_{60} + N_{90}$	28,3	9,6	51,3	6,50	2,58	65,81
Background – minimal tillage without fertilizing (T)	22,6	-	100	4,70	-	100
$P_{90}K_{60}$	25,1	2,5	11,0	5,15	0,45	9,57
N_{90}	26,7	4,1	18,3	5,76	1,06	22,55
$P_{90}K_{60}N_{90}$	33,4	10,8	47,7	7,48	2,78	59,14
$P_{90}K_{60} + N_{90}$	35,8	13,2	58,4	8,20	3,50	74,46

According to the data, the yield was high, especially in the background of minimal tillage, which is associated with the accumulation of moisture in the soil and its effective use. The impact of dates of fertilizer application on both the quantity and quality of the crop is obvious.

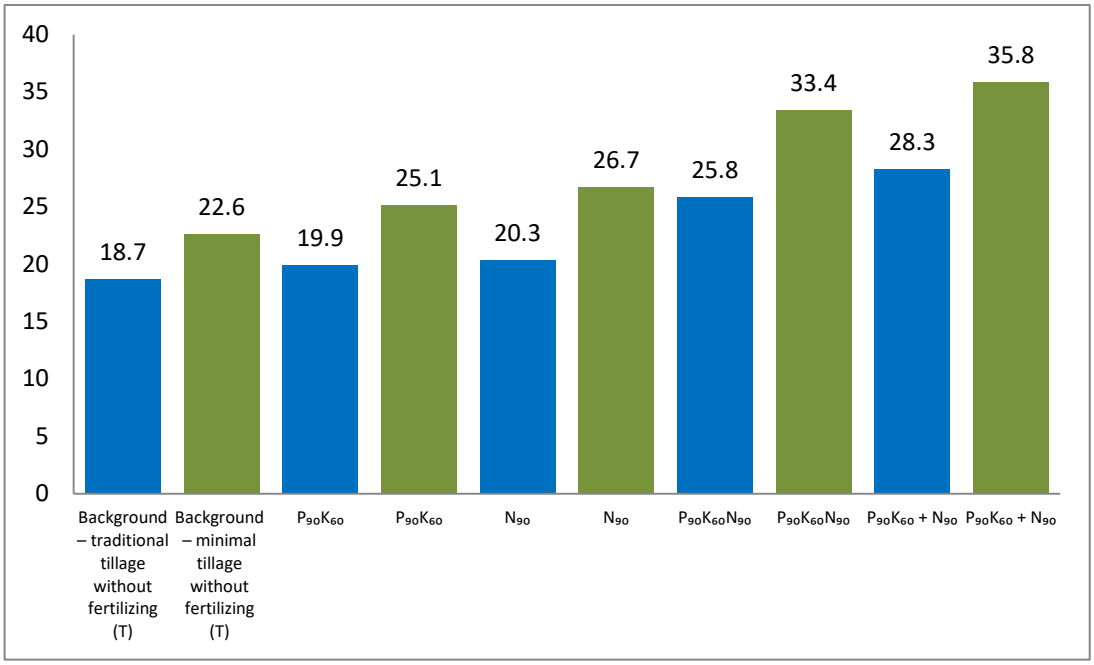

Fig. 1 Yield of winter wheat depending on the methods of soil cultivation and fertilization time

Conclusion

In the conditions of rainfed agriculture in the lowland zone of the Artsakh Republic, where the yield of crops depends mainly on the general tension of the environment and the applied agro-technical measures should be aimed at the effective use of atmospheric moisture. In order to increase the drought resistance of plants and to use moisture economically, it is necessary to define the best dates for the application of mineral fertilizers.

Numerous studies have shown that nitrogen and complete fertilizers dominated by free-nitrogen applied into the soil before tillage, promote the development of mesophytic traits in plants while phosphorus-potassium fertilizers, on the contrary, create the conditions for xerophytic traits.

Plants of high-yielding and resistant to high environmental tension are grown when phosphorus-potassium fertilizers are applied to the soil before sowing and nitrogen fertilizers are applied in spring as nutrients.

On the other hand, in the conditions of minimal soil cultivation, the differentiation of the arable layer according to fertility and the concentration of fertility elements in the top 0-15 cm layer of soil has a significant impact on plant growth and development. Seeds sown in the biologically active layer germinate simultaneously, their field germination is high, the initial growth of plants is accelerated, the transition stages of development are shortened, the energy of bushing is high, winter crops are well matured during winter, they withstand unfavorable conditions of winter well and yield qualified crops at low cost.

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ԲՆԱԿԱՆ ՊԱՅՄԱՆՆԵՐՈՒՄ ՀՈՂԻ ՄՇԱԿՄԱՆ ԵՂԱՆԱԿՆԵՐԻ ԵՎ ՊԱՐԱՐՏԱՑՄԱՆ ԺԱՄԿԵՏՆԵՐԻ ԱԶԴԵՑՈՒԹՅՈՒՆԸ ԱՇՆԱՆԱՑԱՆ ՑՈՐԵՆԻ ԵՐԱՇՏԱԴԻՄԱՑԿՈՒՆՈՒԹՅԱՆ ԲԱՐՁՐԱՑՄԱՆ ՎՐԱ

Գալստյան Ս.Բ., Առաքելյան Ա.Ա., Աթալյան Ս.Լ., Մինասյան Հ.Վ.
Շուշիի տեխնոլոգիական համալսարան

Էկոլոգիական պայմանների բարդացման հետևանքով մշակաբույսերի բերքատվության անկումն ու կորուստը մեղմելու նպատակով Մարտունու շրջանի հարթավայրային գոտու շագանակագույն խճաքարային հողերում, անջրդի երկրագործության պայմաններում, առաջին անգամ հետազոտվել է հողի հինմական մշակման եղանակների և պարարտացման ժամկետների ազդեցությունը հողի ջրային ռեժիմի կարգավորման և աշնանացան ցորենի երաշտադիմացկունության բարձրացման վրա:

Փորձարարա-հետազոտական ճանապարհով բացահայտվել է ավանդական վարի համեմատությամբ հողի մշակման նվազագույն եղանակի առավելությունը հողի ջրային հատկությունների բարելավման վրա, ինչպես նաև պարզվել է ցանքից առաջ հող մտցված ֆոսֆորակալիումական պարարտանյութերի դրական և ազոտական ու լրիվ պարարտանյութերի բացասական ազդեցությունը ցորենի բույսերի մոտ երաշտադիմացկունություն ապահովող այնպիսի ֆիզիոլոգիական հատկանիշի վրա, ինչպիսին տրանսպիրացիայի ինտենսիվության նվազեցումն է: Միաժամանակ պարզվել է, որ ֆոսֆորակալիումական պարարտանյութերը ցանքից առաջ, իսկ ազոտականը սնուցման ձևով գարնանը հող մտցնելիս ստեղծվում է սննդատարրերի հավասարակշռված բալանսավորում, բույսերի մոտ ապահովվում է քսերոֆիտ հատկանիշների զարգացում և մթնոլորտային գործոնների բարձր լարվածության պայմաններում ստացվում է բարձր բերք:

Բանալի բառեր. առի շրջմամբ հերկ, նվազագույն մշակում, դաշտային խոնավություն, պարարտացման ժամկետ, տրանսպիրացիայի ինտենսիվություն, ցորենի բերքատվություն:

ВЛИЯНИЕ СПОСОБОВ ОБРАБОТКИ ПОЧВЫ И СРОКОВ ВНЕСЕНИЯ УДОБРЕНИЙ НА ПОВЫШЕНИЕ ЗАСУХОУСТОЙЧИВОСТИ ОЗИМОЙ ПШЕНИЦЫ В ЕСТЕСТВЕННЫХ УСЛОВИЯХ

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В целях снижения потерь урожая сельскохозяйственных культур в связи с ухудшением экологической обстановки, на коричневых щебнистых почвах равнинной зоны Мартунинского района, впервые было исследовано влияние способов основной обработки почвы и сроков внесения удобрений на регулирование водного режима почвы и повышение засухоустойчивости озимой пшеницы в условиях богарного земледелия.

Экспериментально-исследовательским путем было выявлено преимущество минимального способа обработки почвы на улучшение водных свойств почвы, по сравнению с традиционной вспашкой, а также установлено положительное влияние фосфорно-калийных удобрений, внесенных в почву перед посевом, и отрицательное влияние азотных и полных удобрений на такой физиологический признак, как снижение интенсивности транспирации, обеспечивающей засухоустойчивость зерновых культур. Было также установлено, что фосфорно-калийные удобрения, внесенные в почву весной, перед посевом, а азотные удобрения - в виде подкормки, создают баланс питательных элементов, повышается засухоустойчивость растений и в условиях высокого напряжения атмосферных факторов увеличивается их урожайность.

Ключевые слова: оборотный плуг, минимальная обработка, полевая влажность, сроки внесения удобрений, интенсивность транспирации, урожайность пшеницы.

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