UDC 633.16:632.9:631.445.24:631.95
TRUFANOV A., Candidate of Agricultural Sciences, docent,
e-mail: a.trufanov@yarcx.ru
CHEBYKINA E., Candidate of Agricultural Sciences, docent,
e-mail: e.chebykina@yarcx.ru
SHCHUKIN S., Candidate of Agricultural Sciences, docent,
e-mail: s.shhukin@yarcx.ru
KOTYAK P., Candidate of Agricultural Sciences, senior lecturer,
e-mail: p.kotyak@yarcx.ru
«Yaroslavl state agricultural academy», Russia

PHITOSANITARY CONDITIONS OF BARLEY AND SOD-PODZOLIC GLEYEY SOIL UNDER ECOLOGICAL FARMING

On the basis of field and laboratory experiments and studies establish a relationship weed harmfulness of the abundance and species of the weed, phitosanitary conditions of the soil and applied methods of growing technology under ecological farming Non-chernozem zone of Russia.
Keywords: *ecological farming, soil tillage, productivity, agrophytocenosis, phytosanitary conditions, weeds, reproductive organs, weed seeds*

Introduction. Losses caused by weeds, significant. Thus, 10 per 1m^2 vegetation weeds in barley reduces grain yield of 1.6 t / ha, 50 weeds - 4.4, 100 - 6.1, 200 - 7.6, 300 - 9.4 t / ha with a yield in the weed-free crops - 45.5 c / ha [1].

The harm caused by weeds is multilateral: they obscure crops, delaying their vegetation, consume large amounts of nutrients and water, have a negative allelopathic impact and so on [2].

Therefore, the weed control was and remains one of the major problems of agriculture, and a large role in this is played by a mechanical method, which is based on soil tillage.

Rational and timely soil tillage can reduce weediness biennial and perennial weeds minors by 50-60%. It helps increase competitive ability of crops [3].

Selection of the optimal tillage system lies in the wide range of possible solutions from the traditional plowing to no-till systems through a many options including subsurface, shallow tillage and their combinations, depending on the agro-ecological conditions, requirements of crops and level of intensification. Moreover, the application of the system of plowing in weed control is not always effective method of reduction weed biological groups [4]. Furthermore, the system of tillage should be considered as an element of agricultural technology certainly located in close cooperation with other elements: crop rotation, fertilizer systems, plant protection systems etc.

Meanwhile, the current in the world is the reasonableness of search strategies for weed control based on ecological principles and processes [5].

In this regard, the aim of the research was to study the changes and relationships phytosanitary condition of barley, potential weediness of the soil and crop productivity when used in growing technology resource-saving agricultural practices (soil tillage and fertilizers systems) in terms of ecological agriculture Non-chernozem zone of Russia.

Materials and methods. Experimental work was carried out in 2012-2013 in the crop of barley (variety Elf) in the field three-factor experiment, laid on the experimental field research laboratory resource-saving technologies in agriculture technology faculty of "Yaroslavl SAA" (using scientific equipment CCU "Agrotechnologies") by split plots with random placement options in repetitions. Repeated experience fourfold. Experience laid in 1995 in the rotation in time: Barley - vetch-oat mixture - winter rye and so on.

The experimental setup at the sod-podzolic gleyey clay loam soil: on plots of first-order area of 756 m^2 (54 m × 14 m) studied 4 tillage systems, on plots of second-order area of 126 m^2 (14 m × 9 m) - 6 fertilizer systems and third-order plots area of 63 m^2 (9 m × 7 m) - 2 plant protection systems. Factor A. Soil tillage system ("O") : 1.Plowing: plowing 20-22 cm preliminary disking or

stubbling 8-10 cm per year, "O_1"; 2. Superficial with loosening: loosening the 20-22 cm with a preliminary stubbling by 8-10 cm 1 time in 4 years + single superficial tillage for 6-8 cm in the remaining three years , "O_2" ; 3. Superficially-plowing: plowing 20-22 cm preliminary disking or stubbling 8-10 cm 1 time in 4 years + single superficial tillage for 6-8 cm in the remaining three years , "O_3" 4. Superficial: a single disk shelling or stubbling by 6-8 cm per year, "O_4". Factor B. Fertilizer system ("U") : 1.No fertilizers, "U_1"; 2.N_{30}, «U_2» ; 3.Straw 3 t/ha (of cereal crops), "U_3"; 4.Straw 3 t/ha + N_{30}, "U_4"; 5.Straw 3 t/ha + NPK, "U_5" (norm of fertilizers on crop yields planned to 30 t/ha - $N_{65}P_{75}K_{160}$); 6.NPK, "U6" ($N_{65}P_{75}K_{160}$). Factor C. Plant protection system ("G"): 1.No herbicides, "G_1"; 2.Using herbicides, "G_2" ("Lontrel 300" rate of 0.5 l/ha in tillering phase of the barley) .

Before beginning the study the content of organic matter in the soil layer was 2.50% , a available phosphorus - 204.0 and potassium - 96.0 mg/kg, pH - 5.7.

Weather conditions for the period of research were generally favorable for barley, as the air temperature was close to the average with a slight increase, while rainfall was above average long-term level, especially in the first half of the growing season.

Number, dry weight of all species of weeds and potential weeding of the soil by vegetative organs of perennial weeds was determined according to B. Smirnov and V. Smirnova [6]. Also measured change in total number of species within biogroups biannual and perennial weed and structure component of an agrophytocenosis. Abundance of weed seeds in the soil was determined by small samples [7]. Barley yields take into account the continuous method, followed by correction for humidity 14% and 100% purity. Statistical analysis of experimental data using the program «STRAZ», «Disant», «Statistica 7 », «Microsoft Excel».

Results and discussion. Agrolandscape area with sod-podzolic gleyey soils formed under short flooding groundwater and characterized by high weeding not only biannual, but especially perennial species of weeds. An increase in weediness of these lands helps a very short period for timely tillage, especially energy-intensive annual plowing.

During resource saving tillage systems (O_2, O_3, O_4) observed increase in weed infestation which was associated with the growth of perennial weeds, while the number of annual and biannual weeds was slightly (Table 1). Reducing of a mechanical effect on the soil leads to more intense accumulation of dry mass as perennial and biannual species of weeds.

Fertilizer use has led to an increase the number weeds in the agrophytocenosis. Adding planned amounts of fertilizer, increased the number of weeds in 1.85 times, and its application on straw background aftereffects 2.4 times. Despite the growth of weeds, accumulation of dry mass of perennial species decreased by 50% compared with the control. Dry weight of biannual weeds when fertilizer add increased the growth of their population.

Under the reduction of the intensity of tillage in the group stages of the dominance of perennial weed forming prevailed: Convolvulus arvensis, Cirsium arvense, Sonchus arvensis and tuberous: Stachys palustris.

Increasing in the number of biannual weeds under resource-saving tillage systems (O_2, O_3, O_4) due to cenopopulation of Matricaria perforata, Viola arvensis, Galium aparine, Myosotis arvensis, as well as codominants - Spergula arvensis, Apera spica-venti, Centaurea Cyanus, Capsella bursa-pastoris.

Use of fertilizers, especially mineral, helped to reduce the proportion of all perennial weeds and increased the share of biannual weed species. Population decline occurred with increasing levels of nutrition. Aftereffect on the background of straw increased cenopopulations of Sinapis arvensis and Fumaria officinalis, and for mineral fertilizers - Matricaria perforata, Galium aparine, Galeopsis speciosa, Thlaspi arvense, Stellaria media, Capsella bursa-pastoris.

Possible appearance in a field of weed species characterized by potential weediness soil of vegetative organs of reproduction.

Table 1

Number and dry weight of weeds during the growing season barley in average depending on the studied factors

Variant	Number, pcs./m^2			Dry weight, g/m^2		
	total	including		total	including	
		perennial	biannual		perennial	biannual
Factor A. Soil tillage system, «O»						
Plowing, «O_1»	53,4	3,4	50	18,3	1,9	16,3
Superficial with loosening, «O_2»	59,7	6,7	53	25,3	3,2	22,1
Superficially-plowing, «O_3»	55,5	7,5	48	21,3	3,4	17,9
Superficial, «O_4»	65,4	10,4	55	24,7	3,9	20,7
SED_{05}	$F_f<F_{05}$	2,8	$F_f<F_{05}$	$F_f<F_{05}$	1,9	$F_f<F_{05}$
Factor B. Fertilizer system, «U»						
No fertilizers, «U_1»	37,7	8,7	29	15,4	5,0	10,3
N_{30}, «U_{2}»	51,5	6,5	45	23,4	2,9	20,4
Straw, «U_3»	38,3	6,3	32	20,3	3,3	17,0
Straw + N_{30}, «U_4»	60,3	8,3	52	23,4	2,6	20,8
Straw + NPK, «U_5»	91,6	6,6	85	23,5	2,4	21,1
NPK, «U_6»	69,8	5,8	64	28,4	2,5	25,9
SED_{05}	19,5	$F_f<F_{05}$	18,4	9,41	1,4	9,73
Factor C. Plant protection system, «G»						
No herbicides, «G_1»	59,9	6,9	53	22,6	2,76	19,8
Using herbicides, «G_2»	57,1	7,1	50	22,2	3,49	18,7
SED_{05}	$F_f<F_{05}$	$F_f<F_{05}$	$F_f<F_{05}$	$F_f<F_{05}$	$F_f<F_{05}$	$F_f<F_{05}$

Combined tillage systems that combine plowing and surface tillage (O_2, O_3) provide approximately the same level of infestation of the soil weed seeds in comparison with the annual plowing (O_1) tillage (Table 2).

In effect of fertilizer systems clearly shown a trend to increase the number of weed seeds in the soil with increasing levels of nutrition.

The structure of the species composition of biannual weed seeds under different tillage systems changed insignificantly. However, reducing the mechanical effect on the soil led to the emergence in field of Spergula arvensis and increase the number of seeds of Matricaria perforata, Thlaspi arvense and perennials.

Adding together NPK with straw (U_5) helped to reduce the number of seeds in the soil of Matricaria perforate by 16% , Viola arvensis by 22% and Capsella bursa-pastoris by 73.5 %, with increased participation of Chenopodium album, Myosotis arvensis, Thlaspi arvense.

Under resource-saving tillage systems (O_2, O_3, O_4) significantly increases the length of the vegetative organs in 2.0-2.2 times in comparison with the annual plowing tillage (O_1). Not dependent on the depth of tillage, most of the root system of weeds concentrated at the top of the plow horizon (0-10 cm), which facilitates activities to destroy them. Trends noted by changes in the length of the vegetative organs were similar and the accumulation of dry mass of roots.

Periodic plowing in Superficially-plowing tillage system (O_3) provides a decline in species of vegetative organs in the soil. In these variants are not met Agropirum repens and Equisetum arvense, decreased participation of Sonchus arvensis by 12.6 % , Cirsium arvence by 8.8% and Stachys palustris by 5.3%, but increased to 4.7 times the share of Convolvulus arvensis in comparison with the plowing system (O_1). .

Fertilisation (U_5 , U_6) increased the competitive ability of crop and deter the formation of vegetative organs of weeds .

Table 2

The role of the studied factors in the change of the potential weediness of plowed layer of sod-podzolic gleyey clay loam soil

Variant	Number of seeds, million pcs./ha			Vegetative reproductive organs					
				length, cm/m^2			dry weight, g/m^2		
	soil layer, cm								
	0-10	10-20	0-20	0-10	10-20	0-20	0-10	10-20	0-20
Factor A. Soil tillage system, «O»									
Plowing, «O_1»	171,56	180,47	352,03	101,2	34,8	136,0	2,43	0,92	3,35
Superficial with loosening, «O_2»	183,28	157,03	340,31	166,2	106,0	272,2	4,17	2,62	6,79
Superficially-plowing, «O_3»	168,28	184,22	352,50	166,5	119,8	286,3	2,78	1,52	4,30
Superficial, «O_4»	184,69	180,94	365,63	197,0	102,6	299,6	5,15	2,24	7,39
SED_{05}	$F_f<F_{05}$	$F_f<F_{05}$	$F_f<F_{05}$	70,4	84,8	54,2	1,90	1,40	$F_f<F_{05}$
Factor B. Fertilizer system, «U»									
No fertilizers, «U_1»	143,91	147,19	291,10	180,5	108,4	288,9	3,72	2,20	5,92
N_{30}, «U_{2}»	142,50	181,41	323,91	-	-	-	-	-	-
Straw, «U_3»	207,66	192,19	399,85	-	-	-	-	-	-
Straw + N_{30}, «U_4»	213,75	181,88	395,63	-	-	-	-	-	-
Straw + NPK, «U_5»	44,00	44,80	67,80	144,2	74,3	218,5	4,02	1,89	5,91
NPK, «U_6»	143,91	147,19	291,10	131,7	88,9	220,6	3,24	1,74	4,98
SED_{05}	142,50	181,41	323,91	$F_f<F_{05}$	$F_f<F_{05}$	$F_f<F_{05}$	$F_f<F_{05}$	$F_f<F_{05}$	$F_f<F_{05}$
Factor C. Plant protection system, «G»									
No herbicides, «G_1»	178,83	183,75	362,58	161,0	99,3	260,3	3,90	1,76	5,66
Using herbicides, «G_2»	175,08	167,58	342,66	154,6	82,3	236,9	3,32	1,89	5,21
SED_{05}	$F_f<F_{05}$	$F_f<F_{05}$	$F_f<F_{05}$	$F_f<F_{05}$	$F_f<F_{05}$	$F_f<F_{05}$	$F_f<F_{05}$	$F_f<F_{05}$	$F_f<F_{05}$

You can note the decrease share under adding of mineral fertilizers (U_6): Equisetum arvense by 34% and Convolvulus arvensis by 76.4 % compared with the control (U_1). Using of straw background aftereffect (U_5) increased presence in the topsoil of the vegetative organs of reproduction of Agropirum repens and Stachys palustris in 2 times, and Convolvulus arvensis on 3.4% , but excluded from the species composition of Equisetum arvense.

The yield of barley between tillage systems not discovered to significant differences (Table 3).

Using all fertilizer systems provides significant yield increase. Aftereffect winter rye straw provided higher yields, both in combination with mineral fertilizers, as well as separately.

In terms of agrolandscape on sod-podzolic gleyey clay loam soil herbicide application "Lontrel 300" had no significant effect on the change in weed component agrophytocenosis and barley yields.

Table 3

Barley yields an average of studied factors, c/ha

Variant	Yields, c/ha
Factor A. Soil tillage system, «O»	
Plowing, «O_1»	23,1
Superficial with loosening, «O_2»	19,0
Superficially-plowing, «O_3»	20,8
Superficial, «O_4»	19,7
SED_{05}	$F_f<F_{05}$
Factor B. Fertilizer system, «U»	
No fertilizers, «U_1»	15,4
N_{30}, «U_{2}»	18,8
Straw, «U_3»	18,5
Straw + N_{30}, «U_4»	20,6
Straw + NPK, «U_5»	24,2
NPK, «U_6»	26,2
SED_{05}	2,38
Factor C. Plant protection system, «G»	
No herbicides, «G_1»	20,2
Using herbicides, «G_2»	21,1
SED_{05}	$F_f<F_{05}$

Calculation of correlation between the phytosanitary condition of crops and yield of barley on the studied factors indicates greater severity of perennial weed species (Table 4).

Table 4

Correlation indicators weediness and barley yields

Variant	Perennial weeds		Biannual weeds		Vegetative reproductive organs		Number of seeds, million pcs./ha
	number, pcs./m^2	dry weight, g/m^2	number, pcs./m^2	dry weight, g/m^2	number, pcs./m^2	dry weight, g/m^2	
Factor A. Soil tillage system, «O»							
Plowing, «O_1»	-0,0642	-0,6075	0,7467	0,1602	-0,1078	-0,2082	0,7683
Superficial with loosening, «O_2»	0,0393	-0,2926	0,3511	0,2421	-0,5493	-0,5103	0,0879
Superficially-plowing, «O_3»	-0,4701	-0,6958	0,4720	0,4526	-0,6194	-0,1276	0,8931
Superficial, «O_4»	0,0014	-0,0960	0,4703	0,6319	0,1792	0,0964	0,4376
Factor B. Fertilizer system, «U»							
No fertilizers, «U_1»	-0,4945	-0,5557	0,5941	0,2495	-0,7135	-0,6314	0,5757
N_{30}, «U_{2}»	-0,1961	-0,6929	0,5652	0,4935	-	-	-
Straw, «U_3»	-0,2083	-0,0373	0,5945	0,2754	-	-	-
Straw + N_{30}, «U_4»	-0,2196	0,0607	-0,8047	-0,8332	0,2685	-0,3494	-0,2910
Straw + NPK, «U_5»	-0,1998	-0,2449	-0,7388	-0,3996	-0,6019	-0,5292	0,3810
Factor C. Plant protection system, «G»							
No herbicides, «G_1»	-0,3975	-0,5154	-0,3975	0,1371	-	-	-
Using herbicides, «G_2»	-0,3288	-0,5338	-0,3288	0,4450	-	-	-

Under all the studied systems of tillage observed negative correlation. In accordance with the correlation coefficient obtained in the analysis of biannual species of weeds and yield of barley, their effect was positive in all tillage systems.

Harmfulness weed of agrophytocenosis increased with increasing levels of nutrition. Correlation yield and perennial weed species was also back, but unlike biannual weeds here tightness correlation was higher with no fertilizer (U_1) and the aftereffect straw (U_3). Correlation analysis yields depending on the weediness of biannual weeds revealed an average positive relationship at low levels of nutrition (U_1, U_3, U_4) and a strong negative dependence on variants with the NPK (U_6), and at the aftereffect straw + NPK (U_5).

The degree of relation between yield and phytosanitary conditions of crop is higher under using herbicides in plant protection system (G_2) as compared with the variants without their use (G_1).

Development of vegetative reproductive organs of perennial weeds was negatively correlated with the yield of barley. That is, the increasing length of the vegetative organs and their weight decreases the level of crop yield. Under combined tillage systems (O_2, O_3) dependence was average. However, the annual superficial tillage (O_4) correlation was positive, but weak. Between yield and the degree of development of the vegetative organs of perennial weeds set negative average degree of dependence under systems of fertilizers.

Barley yields had a strong positive correlation with potential weediness soil of weed seeds under tillage systems "Plowing" and " Superficially-plowing". At the variants tillage system without plowing, the correlation between these indicators not detected (O_2) or it was an average degree (O_4). At the variants with mineral fertilizers the yield dependence of weed seeds in the soil was moderately positive, and when used on a background of straw aftereffect - a weak negative.

Conclusions. Application of the combined superficially-plowing tillage allows to maintain the level of weed infestation below the critical threshold of harmfulness, not exceeding the values of annual plowing, and reduces weeding of the soil reproductive organs due to differential alternation plowing and superficial tillage that proves the expediency of its application in the sod-podzolic gleyey clay loam soils. In general, ecological farming agricultural practices (resource-saving superficially-plowing tillage and using cereal straw of predecessors without herbicide application) maintains the phytosanitary condition at a safe level and increase the yield of barley.

References

1. Самерсов В. Ф. Засоренность посевов в Белоруссии и пути ее ослабления / В. Ф. Самерсов, К. П. Паденов, С. В. Сорока // Защита и карантин растений. – 2000. – № 3. – С. 20–22.

2. Земледелие / [Баздырев Г. И., Захаренко А. В., Лошаков В. Г. и др.]: под ред. Г. И. Баздырева. – М.: КолосС, 2008. – 607 с. – (Учебники и учеб. пособия для студентов высш. учеб. заведений).

3. Баздырев Г. И. Защита сельскохозяйственных культур от сорных растений / Г.И. Баздырев. – М.: Колос, 2004. – 328 с.

4. Щукин С. В. Экологическая роль сорных растений при применении систем энергосберегающей обработки почвы / С. В. Щукин, А. М. Труфанов, Р. Е. Казнин, Е.В. Чебыкина // Вестник АПК Верхневолжья. – 2012. – №3(19). – С. 30-34.

5. Liebman M. Ecological management of agricultural weeds / Liebman M., Mohler Ch. L., Staver Ch. P. – Cambridge: Cambridge University Press, 2004. – 525 p.

6. Смирнов Б. А. Методика учета засоренности посевов в полевом стационарном опыте / Б. А. Смирнов, В. И. Смирнова // Доклады ТСХА. – 1976. – № 2. – С.28-32.

7. Доспехов Б. А. Учет засоренности почвы семенами сорных растений методом малых проб / Б. А. Доспехов, А. Д. Чекрыжов // Известия ТСХА. – 1972. – № 2. – С.15-20.

Анотація

Труфанов А.М., Чебикіна Е.В., Щукін С.В., Котяк П.А.

Фітосанітарний стан посіву ячменю та дерново-підзолистого глеюватого ґрунту в умовах екологізації землеробства

На основі польових та лабораторних дослідів і досліджень встановлена залежність шкодочинності бур'янового компонента агрофітоценозу від великої кількості та видового складу бур'янів, фітосанітарного стану ґрунту та застосовуваних прийомів технології вирощування у рамках екологічного землеробства Нечорноземної зони Росії.

Ключові слова: *екологічне землеробство, обробіток ґрунту, врожайність, агрофітоценозів, фітосанітарний стан, бур'яни, вегетативні органи розмноження, насіння бур'янів*

Аннотация

Труфанов А.М., Чебыкина Е.В., Щукин С.В., Котяк П.А.

Фитосанитарное состояние посева ячменя и дерново-подзолистой глееватой почвы в условиях экологизации земледелия

На основе полевых и лабораторных опытов и исследований установлена зависимость вредоносности сорного компонента агрофитоценоза от обилия и видового состава сорняков, фитосанитарного состояния почвы и применяемых приемов технологии выращивания в рамках экологического земледелия Нечерноземной зоны России.

Ключевые слова: *экологическое земледелие, обработка почвы, урожайность, агрофитоценоз, фитосанитарное состояние, сорные растения, вегетативные органы размножения, семена сорных растений*