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MONITORING OF SUGAR BEET CROPS WEEDINESS DEPENDING ON AGRICULTURE SYSTEMS

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Abstract

The results of the agriculture systems impact of on sugar beet agrophytocenosis weeds studies has been presents. The studies were conducted in the field experiment of the Agriculture and herbology department (Agronomic Research Station of the National University of Life and Environmental Sciences of Ukraine), which is located in the Forest-Steppe of Ukraine. The studies were performed in a five-track rotation with the following alternation of crops: peas-winter wheat-sugar beet-barley-corn for grain. Three variants of intensive, ecological and biological agriculture systems have been studied. Within each system of agriculture, was studied four variants of basic tillage in crop rotation: differentiated (control), subsurface, periodical moldboard (shelf+shelf-free), reduced (surface). Laboratory and field studies the impact of agriculrure systems on the crop weediness degree and formation of agrophytocenosis weed component have been determined. An intensive and ecological agriculture system has been found to be a favorable option, which has significantly reduced the number and weight of weeds. The use periodical moldboard (shelf+shelf-free) tillage helps to reduce weeds compared to differentiated tillage.

Key words*: agriculture system, sugar beet, tillage, weeds.*

INTRODUCTION

Weediness of crops is one of the factors that reduce the effectiveness of technological activities (fertilizer, varieties and other) during cultivation of agricultural crops which are aimed at increasing their yields (Tkachenko & Roik, 1998; Tsvey, 2014). Weeds control in the agrocenoses rotation provides increased yields of each crop and improve the plants quality products (Stupakov, 1984). Sugar beet crops in the initial vegetations stages increasing herbal mass slowly, so are not able to compete with weeds in the struggle for the use of moisture, nutrients and solar radiation (Royik, 2001; May & Wilson, 2006; Kyryliuk, 2013). Especially visible influence is the impact of weeds on the sugar beet crops in the 1st vegetation period (from germination to rows closing) (Gorobets et al., 2000; Fedorenko et al., 2012; Egley, 1986). Sugar beet crops are extremely sensitive to the small quantities of weeds presenc. The presence of 1 of the weed plant per 1 m^2 can reduce root yield by 11.7% (Longden, 1989). With ineffective control of weeds reduced productivity of sugar beet reaches 80% of the possible yields level (Rosso et al., 1996; Petersen, 2004), and additional weed control activities and especially in wet years significantly increases the amount of expenses associated with farming cultures (Petit et al., 2013). So, in 80 days' combines vegetation weeds complex absorbs from the soil the same amount of nutrition, which is enough to formation of sugar beet yield (45-55 t/ha) with associated ground mass (Ivashchenko et al., 2002).

The main causes of high crops weedy is biological weeds properties and failure to comply with organizational and economic activities (Zuza, 2002; Ivashchenko, 2001).

The German farmers experience (Zakharenko, 2000), which are engaged an organic control without the use of herbicides and to obtain good yields. This is one of the key of organic farming and weed control should be an integral part of the strategic concept, based on careful crop rotations planning and it observance. In biology agricultures conditions, especially in the transition years, 3-4 years, according to

scientific data, weed growth can increase (Saranin et al., 1997).

Soil machining is an effective factor in reducing crop weediness. New systems of mechanical weeds control in sugar beet crops are not inferior to the use of herbicides in efficiency (Bhagirath et al., 2014; Scherner et al., 2016). Deep plowing in the main tillage helps to reduce the weediness of crops by clearing the topsoil from viable weed seeds (Melander et al., 2017).

In the case of annual moldboard tillage, typically chernozem loses the optimal structures parameters, which degrades its water and air conditions. It is possible to improve the fertility of typical chernozem by replacing the traditional shelf soil tillage - on shelf-free or reduced tillage (Huwe, 2002). With reduced tillage, weed seeds are concentrated in the upper soil layer and massively sprout in spring under favorable conditions, which requires the application of additional weed control measures. The depth of shelf-free tillage reducing influence on changes the temperature and water regime of the soil, can stimulate a changes in the number and weeds species composition in sugar beet crops coenosis (Kyryliuk, 2013; Peters et al., 2014).

The purpose of the publication is to reveal the impact of agriculture systems on the actual sugar beet crops weediness.

MATERIALS AND METHODS

The researches were carried out during 2010-2018 in the conditions of stationary field experiment of the Agriculture and herbology Department - Agronomic Research Station of the National University of Life and Environmental Sciences of Ukraine, which is located in the right-bank Forest-Steppe of Ukraine. The studies were carried out in a five-crop rotation with the following crops alternation: peas - winter wheat - sugar beet -barley - corn for grain.

The soil of the experimental area - is the typical low humus chernozem. The humus content in the arable soil layer is 4.4%, pH - 6.8. The climate is temperate continental. The average air temperature for the year is 6.5-7^{0}C. The average annual rainfall is 540-560 mm, during the growing season - about 65% of the annual average.

Intensive system of agriculture (technogenic-chemical, control) - priority use of industrial fertilizers for the reproduction of soil fertility with the application of 12 tons of manure per hectare of crop rotation and 300 kg NPK ($N_{92}P_{100}K_{108}$), intensive use of pesticides and mineral fertilizers. Ecological agriculture system - priority use for the soil reproductions fertility organic fertilizers with the application per hectare of 18 tons of organic matter, from them (12 tons of manure, 6 tons subsistence crop, mass of stubble green accounting in manure) and 150 kg of active ingredient of fertilizers ($N_{46}P_{49}K_{55}$), with the pesticides use according to criterion of ecological and economic threshold of pests organisms presence.

Biological (organic) agriculture system - use only natural, organic fertilizers with the application per square hectare 17 tons of organics (12 t manure 5 t non-tradable parts of the crop accounting in manure) to restore soil fertility without making industrial agrochemicals and pesticides, but using biological methods of crop protection against pests.

Within each farming systems we studied 4 variants of primary tillage in crop rotation: 1) differentiated cultivation (control), which is recommended for the Forest-Steppe of Ukraine, and provides for rotation of six shelf cultivation, two surface - for winter wheat after peas and corn for grain, one flat-cut cultivation for barley after sugar beet; 2) multi-depth subsurface tillage under all crops of rotation, with the exception of the surface treatment disc guns under winter wheat after peas and corn silage; 3) periodical moldboard (shelf+shelf-free) tillage, which includes plowing under sugar beet, surface plowing under winter wheat after peas and corn on silage and subsurfase tillage under the rest of crops; 4) surface tillage of disk tools for all crops at a depth of 8-10 cm Under the sugar beet in intensive agriculture, 40 t/ha and mineral fertilizers $P_{90}K_{120}$ were applicated into the main tillage, $N_{60}P_{35}K_{15}$ in the pre-sowing period, and $N_{60}P_{15}K_{15}$ fertilization. Under the ecological system, fertilizer resources mainly tillage were, respectively, organic - 67.5 t/ha and mineral $P_{30}K_{40}$, pre-sowing - $N_{20}P_{20}K_{20}$ and fertilizing N_{20}. In organic farming, only organic fertilizers

- 67.5 t/ha (40 t of manure + 20 t of the greenery oilseed radish + 7.5 t of previous winter wheat straw) were used for soil fertilization.

The following observations were made in agrophytocenoses of sugar beet: crops weediness in phase of 2-4 true leaves was quantified, and before harvest quantitative-weight method (at fixed places with size 0.25 m^2; species composition of weeds; yield accounting is a continuous method (Manko et al., 1998).

The area of the elementary accounting zone is 93.6 m^2. Experiment repeatability - four times. Experience options are laid down by the method of split plots.

RESULTS AND DISCUSSIONS

Analysis of the information obtained during the first weed count at the beginning of the growing season of cultivated plants showed a clear significant increase in the weedinees of the experimental plots in biologycal agriculture variants. The highest number of weeds was established on the surface tillage variant for the biological system of agriculture - 372 pcs/m^2, and the lowest - for the industrial agriculture system on the variant with periodical moldboard (shelf+shelf-free) tillage - 92 pcs/m^2, with better effect compared to the control had the variant with periodical moldboard tillage under the ecological system of agriculture, the number of weeds in the areas - 112 pieces/m^2 (Table 1). The organic agriculture model saw a 10% increase in weed abundance compared to the control, which is explained by the direct correlation between germination and organic fertilizer rates r = 0.57. The effect of organic weed fertilizers on the emergence of weed seedlings enhances the use of shelf-free tillage. The analysis of the information obtained during the first accounting of weeds to changes in the botanical structure of weed sinus in the field of sugar beets towards increasing the proportion of juvenile dicotyledons and perennial species under influence of ecological and especially biological models of agriculture. The influence of soil tillage look at tends to increase the proportion of juvenile and perennial monocotyledonous species compared to control under the influence of subsurface and reduced (surface) tillage and decrease - under periodical moldboard tillage systems.

The use of subsurface tillage in crop rotation contributes to increased crop weediness (Manko & Tsyuk, 2002). Some foreign and ukrainian researchers have come to the conclusion that plowing is a more reliable measure of weed control, especially perennial (rhizome and root shoots) than treatment with disk plowers or flat-cut tools (Barshteyn et al., 2002). An increase of organic fertilizers rate in crop rotations leads to an increase of the weediness in sugar beet crops, among which dicotyledonous weeds predominate (Barshteyn et al., 2002).

Before harvest, the control systems of crops were the least polluted by weeds. In models of ecological, and especially organic agriculture, this indicator exceeded the control by 37% and 316%. Increase in weediness occurred in these variants due to monocotyledonous annual and perennial species. The magnitude of the weeds at harvest time was greater than the first.

This fact obviously caused by the dry conditions the first half of the growing season, which is certainly delayed the emergence of weeds. Precipitation in July-August led to the increase of abundance of weeds at the harvest time of sugar beet. The tillage systems of soil treatment best clean fields from weeds at the time the harvest was periodical moldboard (shelf+shelf-free) processing. In this variant, the abundance of all weeds was 16% less than control. This is especially effective variant proved to the effect on perennial weed species, a profusion of which decreased compared to control at 45%.

Observations showed a significant impact of the studied systems of agriculture on the species composition of the crops weediness.

The results' analyzing of the surveys and records, showed that the 21 most common weed species, most of which were perennial species, were identified in sugar beet crops.

As a part of weed sinus rotation (Figure 1) at the beginning of the growing season the most common were two-year-old dicotyledons: sparrow (*Amaranthus retroflexus* L.), white quinoa (*Chenopodium album* L.), scallop (*Calium aparine* L.), mustard twist (*Polygonum convolvulus* L.) and monocotyledonous

monkeys: common squirrel (*Echinochloa crus-galli* L.), mouse bluish (*Setaria glauca* P. Beauv). Among the perennials, there were a small abundance of pink oysters (*Cirsium arvense* L. Scop) and creeping creepers (*Elytrigia repens* L.).

Table 1. Changes in weed sinus in sugar beet crops under the agriculture systems influence (2010-2018)

The agriculture system	Variant of tillage	Weed abundance at the beginning of the growing season, pcs/m^2	Weed mass at the end of the beginning of the growing season, g/m^2	Weed severity at the end of the growing season, pcs/m^2	Weed mass at the end of the growing season, g/m^2
Intensive (control)	Differentiated (control)	123	15.1	22	110
	Subsurface	148	18.2	27	121
	Periodical moldboard (shelf+shelf-free)	92	11.1	18	115
	Reduced (surface)	191	23.1	29	135
Ecological	Differentiated (control)	130	16.2	28	122
	Subsurface	182	22.2	35	144
	Periodical moldboard (shelf+shelf-free)	112	13.4	25	128
	Reduced (surface)	190	23.6	42	140
Biological	Differentiated (control)	236	29.0	75	182
	Subsurface	315	39.2	83	280
	Periodical moldboard (shelf+shelf-free)	188	23.4	63	250
	Reduced (surface)	372	45.9	82	265
Average for farming systems	Intensive	138	16.8	24	120
	Ecological	153	18.8	33	133
	Biological	277	34.3	76	244
Average tillage	Differentiated (control)	163	20.1	42	138
	Subsurface	215	26.5	48	181
	Periodical moldboard (shelf+shelf-free)	130	15.9	35	171
	Reduced (surface)	251	30.9	51	180

Before sugar beet harvesting, there was a significant change in species composition, dominated by annual monocotyledons.

The abundance of juvenile (annual) dicots decreased. Perennial monocotyledonous and dicotyledonous weeds increased their participation in rotation fields to 3-7% with 3%.

An increase in the turbulence of one-year-old monocotyledons at the end of the growing season was facilitated by precipitation and a decrease in the phase of reaching the leaf area, which means competitiveness.

The results of the aboveground mass of weeds in sugar beet crops before harvesting their crop, show a trend of increase in option of organic agriculture to 10% and a significant increase in weight compared with the control of biological agriculture by 203%.

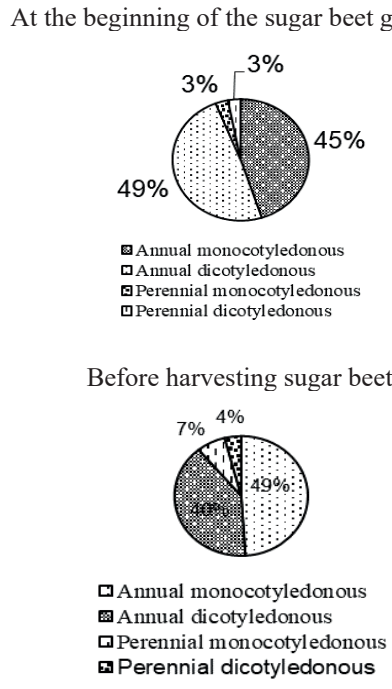

Figure 1. The biological weeds spectrum at the accounting times

It should be noted the positive effect periodical moldboard primary tillage. The best combinations of the investigated factors were the use of shelf+shelf-free or differentiated primary tillage within a resource support systems in intensive and ecological agriculture. In these variants saw a decrease in the mass of weeds compared to shelf-free tillage 23%.

As the yield of sugar beet ecological system were not significantly different from control (Figure 2). It should be noted a significant decrease in comparison with the differentiated version of the yield of sugar beet on subsurface and surface treatments of the soil in the crop roation.

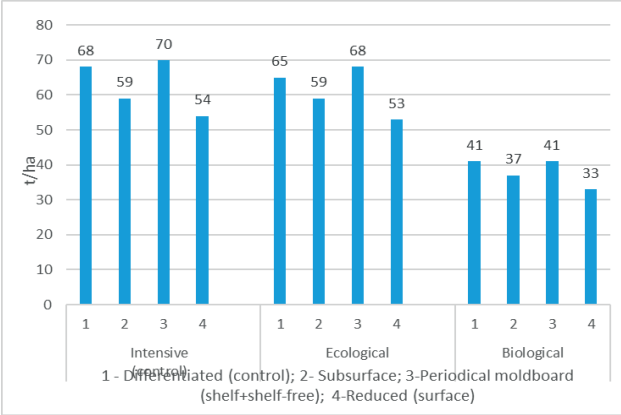

Figure 2. Sugar beet yield depending on agriculture systems, t/ha

Periodical moldboard (shelf+shelf-free) basic tillage in crop rotation proved to be the best among the studied variants, which significantly exceeded the control.

CONCLUSIONS

Changes in weed sinusia in sugar beet agrophytocenoses under the influence of agriculture systems in the biological model lead to a significant increase in abundance (by 100% at the beginning of vegetation, by 216% at the end of vegetation), and by the mass of weeds by 203% and a significant increase and participation perennial monocotyledonous species and reduced dicotyledon involvement compared to an intensive farming system. The use of periodical moldboard (shelf+shelf-free) basic tillage helps to reduce weed abundance by 16.6-20.8% compared to control. The variants of subsurface and surface tillage caused a significant increase in the weediness of sugar beet crops.

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