

Special aspects of the development of black currant bushes depending on weediness level in the Ukrainian polissia

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The article provides the results of scientific study of different weediness levels in the currant agrocoenosis of Ukrainian Polissia. The species composition of weeds has been analyzed; it has been found that it is typical for the area. Twelve weed species were found during the study; they included annual (89.8%) and perennial ones (10.2%). A number of species were prevalent among the perennial weeds, namely common dandelion (*Taraxacum officinale* Wigg.) – 2.5 pcs/m², field milk thistle (*Sonchus arvensis* L.) – 2.8 pcs/m², couch grass (*Elytrigia repens* L.) – 8.8 pcs/m², and field sorrel (*Rumex acetostella* L.) – 3.2 pcs/m². The most common annual species of weeds were lamb's quarters (*Chenopodium album* L.) – 44.2 pcs/m², shepherd's purse (*Capsella bursa-pastoris* L.) – 36.3 pcs/m², smooth meadow grass (*Poa annua* L.) – 25.1 pcs/m², and *Amaranthus retroflexus* (*Amaranthus retroflexus* L.) – 19.6 pcs/m². Throughout the study period, the least common weeds in black currant plantations were chickweed (*Stellaria media* L.) – 14.8 pcs/m², annual nettle (*Urtica urens* L.) – 1.6 pcs/m², quickweed (*Galinsoga parviflora* Cav.) – 9.1 pcs/m², and field pansy (*Viola arvensis* Murr.) – 2.6 pcs/m². It has been proven that depending on the weediness level (8-9 points) the area of black currant leaves from a bush decreases by 1.9 m², while the chlorophyll content in the leaves is by 20.8 mg/100 g less. On the contrary, the dry matter content in leaves increases from 29 to 61%. Significant negative effect of weeds on the activity of black currant occupies one of the leading places and leads to a decrease in plant tolerance against sucking pests and diseases. Thus, under high and very high weediness level (8-9 points) the development of anthracnose (*Gioesporium ribis* Mont.) was 32–48%, powdery mildew (*Sphaerotheca mors Uvae*) and septoria blight (*Mycosphaerella ribis* Lind.) 16 and 15% respectively. It has been proven that a high weediness level in black currant plantations reduces the yield of berries by 56%.

Keywords: Black currant; Weeds; Yielding capacity; Weediness level; Phytophagous insects; Diseases

Introduction

Black currant is one of the most valuable vitamin berry crops for medicine and food industry (Postolenko, 2016). In Ukraine, black currant is the leading berry crop; it occupies more than 20% of all berry fields (Dobrucka et al., 2016). Black currant has a special place among berry crops due to its early maturity, high productivity, winter hardiness, the possibility of mechanical harvesting of berries and suitability for almost all types of technological processing (Bakalova et al., 2020). However, many years of cultivation contribute to the spread of diseases, pests and weeds; the decline of berry yield capacity can reach 30% or more (Marsol-Vall et al., 2019). One of the reasons for the low realization of productivity potential is primarily the weediness of industrial currant plantations (Aliev et al., 2018). The high level of weediness complicates mechanized harvesting, reduces the quality and marketable condition of products (Kjaer et al., 2019; Rantala et al., 2019). Literature sources do not have enough data on the level of weediness of black currant agrocoenoses in the Ukrainian Polissia. Therefore, it is relevant to conduct a thorough study of the influence of various weediness levels on black currant plantations and to obtain high yields of berries.

The purpose of the study was to examine the species composition of weeds and investigate the influence of the weediness level on the main components of black currant agrocoenosis in the Ukrainian Polissia.

Materials and Methods

Field studies were conducted during 2017–2019 at the experimental field of Zhytomyr National Agroecological University. The soil of the experimental plots is sod-podzolic; it is characterized by the following agrochemical parameters: the humus content ranged from 1.7 to 2.0%; easily hydrolyzed nitrogen compounds 68–117 mg/kg, high content of mobile phosphorus 145–180 mg/kg, average exchangeable potassium content 87–110 mg/kg, hydrolytic acidity of soil 2.28–2.90 mg-eq/100 g and pH of the salt extract 5.5–6.2. The experiments were based on the methodology of B. A. Dospekhov (1985). In each variant, there were 60 bushes with five replications, 15 bushes in each. Agrestal vegetation was counted at the experimental plots in black currant plantations in spring after intensive sprouting. The calculation was based on the methodology of A. I. Maltsev and was carried out using ocular estimate method and quantitative-weighing method (Maltceva, 1936). A European 9-point scale was used to assess weediness (Table 1). The species composition of weeds was determined in two replicates of the experiment using atlases and reference books (Veselovskiy et al., 1988; Fisyunov, 1984).

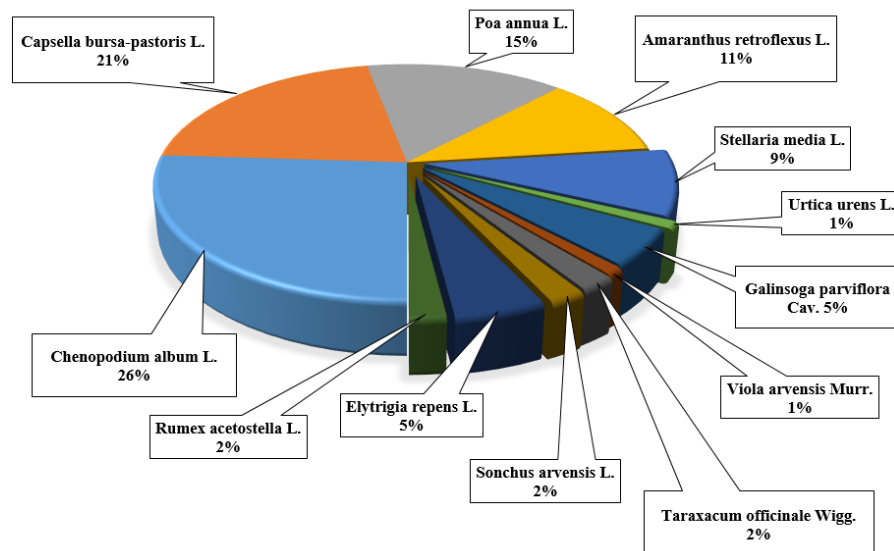
Table 1. Scale used to determine weediness level in black currant plantations.

Weediness points	Weediness level	Number of weeds, pcs/m ²	Weight of weeds, kg	Ocular estimate method
1	very low	0.1–3	0.1	almost no weeds
2–3	low	6–15	0.7	very few weeds
4–5	medium	16–50	1.2	few weeds
6–7	high	51–100	2.2	a lot of weeds, but less than cultivated plants
8–9	very high	more than 100	2.4	more weeds than cultivated plants; and they overgrow cultivated plants

Mathematical processing of experimental data was carried out according to conventional methods using the statistical program Statistika V 5.5 and the data analysis package of the Excel spreadsheet.

Results

The weediness level of black currant plantations was studied; as a result, it has been found that the species composition of weeds is diverse and typical for the investigated area. During the study period, 12 species of weeds (170.6 pcs/m²) were found in the plantations, among them 8 annual species (153.3 pcs/m², or 89.8%) and 4 perennial species (17.3 pcs/m², or 10.2%). The dominant species of annual weeds were *Chenopodium album* L. (44.2 pcs/m², 26%), *Capsella bursa-pastoris* L. (36.3 pcs/m², 21%), *Poa annua* L. (25.1 pcs/m², 15%), and *Amaranthus retroflexus* L. (19.6 pcs/m², 11%). Less common weeds in black currant plantations were *Stellaria media* L. (14.8 pcs/m², 9%), *Urtica urens* L. (1.6 pcs/m², 1%), *Galinsoga parviflora* Cav. (9.1 pcs/m², 5%), and *Viola arvensis* Murr. (2.6 pcs/m², 1%). The perennial species included *Taraxacum officinale* Wigg. (2.5 pcs/m², 2%), *Sonchus arvensis* L. (2.8 pcs/m², 2%), *Elytrigia repens* L. (8.8 pcs/m², 5%), and *Rumex acetostella* L. (3.2 pcs/m², 2%) (Figure 1).

**Figure 1.** Species composition of weeds in black currant plantations, 2017–2019.

It has been found that depending on the different weediness level of black currant plantations, the growth and development of plants changes significantly (Table 2).

Table 2. Influence of different weediness levels on growth and development of black currant, 2017–2019.

Weediness points	Weediness level	Weight of black currant leaves from a bush, kg	Area of black currant leaves from a bush, m ²	Chlorophyll content in black currant leaves, mg/100g	Net photosynthetic yield, g/m ²	Dry matter content in black currant leaves, %
1	very low	1.0	3.1	59.1	3.9	29
2–3	low	0.8	2.8	52.6	3.1	37
4–5	medium	0.6	2.4	47.3	2.6	41
6–7	high	0.4	1.6	42.6	1.8	58
8–9	very high	0.3	1.2	38.3	1.6	61

Depending on the weediness level, the weight of black currant leaves from a bush decreased by 0.7 kg, the area of currant leaves from a bush by 1.9 m², the chlorophyll content in the leaves by 20.8 mg/100 g compared to a very low weediness level (1 point). The dry matter content in currant leaves was 29–61% and, on the contrary, increased by 32% with a very high weediness level.

Weeds are a source of pests and diseases. Violation of biochemical processes in plants led to a decrease in the tolerance of currant to pests and diseases (Table 3).

Table 3. Biological features of the development of sucking pests and diseases depending on the weediness level in black currant plantations, 2017-2019.

points	Weediness level	Density of phytophagous insects per unit			Degree of infestation, %		
		Hyperomyzus lactucae Kalt., specimens/bush	Tetranychus urticae Koch, specimens/leaf	Cecidophyopsis ribis Westw., buds/branch	Gioesporium ribis Mont.	Sphaerotheca mors Uvae.	Mycosphaerella ribis Lind.
1	very low	5	11	2	15	2	4
2-3	low	10	20	5	18	6	7
4-5	medium	30	45	12	29	8	11
6-7	high	80	60	20	32	11	13
8-9	very high	160	75	29	48	16	15

A number of sucking phytophagous insects were found in black currant plantations. Pests were calculated and it has been found that depending on the weediness level, the number of *Hyperomyzus lactucae* Kalt. ranged from 5 to 160 specimens per bush, *Tetranychus urticae* Koch – 11–75 specimens/leaf, *Cecidophyopsis ribis* Westw. – 2–29 buds per branch.

Fungal diseases have become widespread in currant plantations. The dominant disease was *Gioesporium ribis* Mont. It has been found that under a high and very high weediness level (8-9 points) the affection with this disease was 32-48%, which is by 17-33% higher than under a very low weediness level (1 point). The affection with *Sphaerotheca mors Uvae.* and *Mycosphaerella ribis* Lind. Was much lower. Under the weediness level at 8-9 points, the affection with diseases in currant plantations was at the level of 16 and 15%, respectively, which is by 14 and 11% more than under a very low weediness (point 1).

The most important factors for further stabilization and increase of black currant yield capacity are the implementation of intensive cultivation technologies with innovative methods and means of protection against pests, diseases and weeds. Particular attention is paid to the development of fundamentally new methods and tools for identification, control and prediction of the most dangerous harmful species that can cause the maximum level of harm and to the improvement of the existing ones. The ever-increasing requirements for environmental safety are an important stimulus for research and development aimed at regulating the number of weeds in black currant plantations.

Decreased resistance of currant to pests and diseases negatively affected the yield and quality of berries (Table 4).

Table 4. Influence of the weediness level of black currant plantations on the structure and yield of berries, 2017–2019.

points	Weediness level	Weight		Yielding capacity of berries, t			
		an average berry, g	100 berries, g	berries from a bush, kg	average	± to control	%
0-1	very low	2.6	270	1.912	8.5	-	100
2-3	low	2.2	256	1.755	7.8	-0.7	92
4-5	medium	1.9	243	1.462	6.5	-2.0	76
6-7	high	1.1	201	1.283	5.7	-2.8	67
8-9	very high	0.8	185	1.080	4.8	-3.7	56

It has been found that the weediness level in black currant plantations directly affects the structure and yield of berries. Thus, under low and medium weediness level (2-3 and 4-5 points) the weight of an average berry decreases from 2.6 to 0.8 g; on average the weight decreases from 2.2 to 1.9 g. One hundred berries also weigh less; under a very strong weediness level (8-9 points), the 100 berries weighed by 85 g less compared to a very weak weediness level (1 point). Under low weediness level, deviations are insignificant. However, if one takes into account the weight of berries from a bush, the figure is significantly lower, by 157 g. Under the highest weediness level, the weight of berries from a bush decreases from 1.912 to 1.080 kg, i.e., the lack of harvest rapidly reduces the weight of berries by 832 g, and has a direct negative impact on the potential yield capacity of black currant. Over the years of the study, the average yield under different weediness levels decreases from 8.5 to 4.8 t/ha, while the increase in yield under a very high weediness level (8-9 points) decreases by 3.7 t/ha. Thus, the effect of different weediness levels on black currant plantations reduces the yield of berries by 56% and creates conditions for the reservation of sucking phytophagous insects, the number of which increases tenfold, which negatively affects the growth and development of plants.

Discussion

It should be pointed out that weeds not only significantly reduce the yield and quality of berries, but also contribute to the reproduction of pests and pathogens and increase the cost of plant care (Solomahin et al., 2008). Weeds reduce plant growth and productivity in currant agrocoenoses; this is a result of competition for moisture, minerals, shading, etc. (Rohrig et al., 2019; Kendir et al., 2019). Some scientists believe that high weediness of berry crops, especially in the first years after planting, weakens growth and development of plants, and in some cases causes their death (Yang et al., 2019).

When measures aimed at limiting the number of weeds in black currant agrophytoecoenosis are planned, it is necessary to take into account the main ecological and biological features of development and spreading of weeds, their species composition, technique and technological properties for the application of preparations in a particular region (Yang et al., 2019). Many years of experience of scientists have shown that each berry crop in a particular soil and climatic zone has a specific weed coenosis (Sinkevich & Misyuk,

2015). Species and quantitative composition of weeds changes over time depending on the influence of climatic factors and agricultural technologies (Morozov et al., 2018). According to many scientists, the main method of weed control is the use of highly toxic herbicides, which has a negative impact on the environment, reduces the beneficial microflora and affects human health (Tian et al., 2019). Black currant berries are an excellent sorbent during ripening; and this requires great care when choosing preparations, time and methods of their use (Lee & Lee, 2019). It is impossible to provide recommendations for the use of herbicides in berry growing without knowledge of their residual amount in berries (Veselovskyi et al., 1988). The specific aspects of the use of herbicides in berry agrocoenoses are related to the species composition of weeds and their adaptation to the technology of cultivation (Fisyunov, 1984). When herbicides are used to kill weeds, favorable conditions are created for the cultivation of berry crops; they effectively use moisture and nutrients from the soil (Selvaraj et al., 2019; Aliev, 2010). According to some scientists, under the influence of herbicides on weeds under certain conditions, due to the nature of the preparation, biological characteristics of the crop, soil and climatic conditions, as well as the interaction of various factors (Zurn et al., 2019).

Conclusion

The study of the weediness level in black currant plantations identified 12 species of weeds, among them 8 annual species (89.8%) and 4 perennial ones (10.2%). Dominant annual weeds were *Chenopodium album* L., *Capsella bursa-pastoris* L., *Poa annua* L., *Amaranthus retroflexus* L., *Stellaria media* L., *Urtica urens* L., *Galinsoga parviflora* Cav., *Viola arvensis*; while among perennial these were *Taraxacum officinale* Wigg., *Sonchus arvensis* L., *Elytrigia repens* L., and *Rumex acetostella* L.

It has been found that the weediness level of black currant plantations significantly affects the growth and development of plants. Depending on the weediness level, the weight of black currant leaves from a bush decreased by 0.7 kg, the area of currant leaves from a bush by 1.9 m², the chlorophyll content in the leaves by 20.8 mg/100 g compared to a very low weediness level at 1 point. The dry matter content in currant leaves was 29-61% and, on the contrary, increased by 32% under a very high weediness level.

Under a high (6-7 points) and very high (8-9 points) weediness level of black currant, an intensive infestation with sucking phytophagous insects (*Hyperomyzus lactucae* Kalt., *Tetranychus urticae* Koch, *Cecidophyopsis ribis* Westw.) was detected. In addition, the affection with fungal diseases increased (*Gioesporium ribis* Mont., *Sphaerotheca mors Uvae.*, *Mycosphaerella ribis* Lind.)

Decreased resistance of currant to pests and diseases negatively affected the formation of the yield and the quality of berries. Under a very high weediness level, the yield decreased by 3.7 t/ha compared to low weediness, and losses amounted to 56% of the total berry harvest.

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