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UDC 634.8:632.95:632.51
DOI https://doi.org/10.32782/2226-0099.2024.136.2.6

MODERN MEASURES OF CONTROLLING ROOT AND SPROUT WEEDS IN GRAPE AGROPHYTOCENOSES

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In modern economic conditions, scientists search for new technological measures for controlling the number of weeds, especially perennial ones, which would be highly effective and low-cost. The purpose of the research is to objectively analyze the effectiveness of technological measures for controlling the development of pink and gray thistle among industrial grape plantations taking into account their characteristics and modern control measures. The most common root and sprout weeds in agrophytocenoses of industrial grape plantations in the south of Ukraine are pink and gray thistles.

The initial infestation of vineyards by pink and gray thistles occurs due to seeds, and subsequently the weeds spread extremely rapidly due to the buds formed on horizontal roots. Despite the biological features of growth and development of pink and gray thistles, the structure of their root system, they often create a monospecies community, from which all other species of weed synusia are displaced, and compete quite successfully with grape bushes and many types of weed phytocoenosis for moisture and nutrients.

Registration of the number and development of weeds at the end of the stage of grape shoot growth in the areas with fallow land showed that the frequency of spread of pink and gray thistle plants, as part of different biological and cenotic communities, reached 53.1–57.4% with an *average number of 3.4–3.7 pcs./m², which developed along the axis of a row of bushes and a protective strip. The cultivation of intercrops, winter rye and sour sorrel in the row spacing of grapes causes qualitative and quantitative changes in the formation of species composition, the number and development of weeds, including perennial weeds – pink and gray thistle. In the sectors of row spacing free from intercrops, along the axis of the row of bushes and the protective strip, the development of pink and gray thistle does not differ significantly from similar processes in the area with fallow land.*

It was found that traditional control measures are ineffective because they do not ensure complete removal of weeds and require large expenditures of material and financial resources. The most promising for reducing costs and achieving maximum efficiency in the fight against pink thistle is the integrated application of agrotechnical, phytocoenological and chemical measures, with the obligatory consideration of the biological characteristics of the weed development.

Key words: *segetal vegetation, weediness, herbicides, analysis of the effectiveness of technological measures, winter rye, sour sorrel, plant cultivation measures, pink thistle, gray thistle.*

Минкіна Г.О. Сучасні заходи боротьби з коренепаростковими бур'янами в агрофітоценозах винограду

В сучасних умовах господарювання ведеться пошук нових технологічних заходів контролю чисельності бур'янів, особливо багаторічних, які були б високоефективними та маловитратними. Метою проведення досліджень є об'єктивний аналіз ефективності технологічних заходів контролю розвитку осоту рожевого та сивого серед промислових насаджень винограду враховуючи їх особливості та сучасні заходи боротьби. Найбільш розповсюдженими коренепаростковими бур'янами в агрофітоценозах промислових насаджень винограду на півдні України є осот рожевий та сивий.

Початкове проникнення осоту рожевого та сивого на виноградники забезпечує насіння, а в наступному забур'яненість поширюється надзвичайно швидкими темпами завдяки брунькам, що формуються на горизонтальних коренях. Не дивлячись на біологічні особливості росту та розвитку осотів рожевого та сивого, будову їх кореневої системи, вони дуже часто створюють моно видове угрупування, звідки витісняються всі інші види синузії бур'янів, досить успішно конкурують з виноградними кущами та багатьма видами фітоценозу бур'янів за вологу та поживні речовини.

Обліки чисельності та розвитку бур'янів, проведені в кінці фази ріст пагонів винограду, на ділянках, ґрунт яких утримувався у стані чорного пару показали, що частота поширення рослин осоту рожевого та сивого, у складі різних біолого-ценотичних угрупувань досягала 53,1–57,4% з середньою чисельністю 3,4–3,7 шт./м², які розвивалося по осі ряду кущів та захисної смуги. Вирощування в міжряддях винограду проміжних культур, озимого жита і щавлю кислого, зумовлює якісні та кількісні зміни у формуванні видового складу, чисельності і розвитку бур'янів, у тому числі і багаторічних – осоту рожевого та сивого. В секторах міжрядь, вільних від проміжних культур, по осі ряду кущів та захисної смуги, розвиток осоту рожевого та сивого суттєво не відрізняються від аналогічних процесів на ділянці, що утримувалася постійно у стані чорного пару.

Встановлено, що традиційні заходи контролю малоефективні тому що не забезпечують повного видалення бур'янів, потребують великих витрат матеріальних та фінансових ресурсів. Найбільш перспективним для скорочення витрат та досягнення максимальної ефективності в боротьбі з осотом рожевим являється комплексне застосування агротехнічних, фітоценологічних та хімічних заходів, з обов'язковим урахуванням біологічних особливостей розвитку бур'яну.

Ключові слова: *сегетальна рослинність, забур'яненість, гербіциди, аналіз ефективності технологічних заходів, озиме жито, щавель кислий, заходи культивування насаджень, осот рожевий, осот сивий.*

Problem statement. In the centuries-long history of agriculture, the problem of finding effective measures to regulate the number of weeds has always been one of the most pressing, never stopped being topical. On the long path of searching, the first and most rational invention was the transition from manual labor to the use of animal traction in the process of tillage and weed control. Subsequently, the plow was introduced to farming practices, and its widespread use allowed for more effective control of the development and reduction of perennial weeds. Today, under modern economic conditions, scientists search for new technological measures for controlling the number of weeds, especially perennial ones which would be highly effective and cost-efficient.

Analysis of recent research and publications. The analysis of literature sources showed that industrial grape plantations are created within 4–5 years and cultivated in one place for 25–30 years or more. During this time, specific segetal vegetation is formed among the grape plantations, for the control of which certain measures are applied. The implementation of them causes large expenditures of financial and material resources, negatively affecting the efficiency of viticulture [1,2].

The species composition of perennial weeds that infest vineyards includes root and rhizome, creeping, taproot, corm and bulb weeds. All of them are represented among vineyards by a different number of species and occupy their own, clearly defined niche. Perennials include about 260 species, including ornamental plants, honey plants, and nuisance weeds. The group of root and sprout weeds is particularly diverse, with thistle as a typical representative, which is characterized by high expansion and resistance to specially targeted control measures due to the structure of its root system [3,4]. Two plants that are very similar in biological and morphological characteristics are pink thistle (Cirzsium arvense) and gray thistle (Cirzsium incanum Fisch), are weeds in vineyards. Gray and pink thistles are widespread among many agricultural crops, which differ in the structure and development of the root system, partly in phenology, and in the response to measures for controlling their presence among perennial plantations. The biological and morphological characteristics of pink and gray thistles do not prevent their joint development and their being extremely competitive and harmful to grape plantations [5]. Snihovyi V.S., Maliarchuk M.P., Sidenko V.P., state that for the formation of 3–4 t/ha of green mass, thistles take out 70–80 kg of nitrogen, 50–55 kg of phosphorus, and 80–85 kg of potassium from the soil and about 2400–3200 m^3 of soil moisture reserves, which would be quite enough to obtain 8–9 t/ha of high quality grape berries [7]. According to O.O. Ivashchenko, deep penetration of the root system of pink thistle into the soil and the presence of a large number of buds on it complicate the use of traditional measures for controlling the development of pink thistle, significantly reducing their effectiveness. The gray thistle is more vulnerable to mechanical destruction, but this requires deep plowing, which is quite costly in vineyards, and can also damage a significant part of the roots of grapes, and its effectiveness in reducing the number of weeds does not exceed 7–10% [8].

The study of this issue is very important today, as the hostilities result in damage to the soil by tanks and other heavy military equipment. The land needs to be restored, including reclamation and leveling of the earth's surface [9].

In addition, in the de-occupied territories, weed control measures in grape plantations were insufficient or not carried out at all. Therefore, the study of the impact of technological measures to control the presence of pink and gray thistle among industrial grape plantations in the current conditions of the South of Ukraine is undoubtedly a topical issue that requires further scientific substantiation.

Task statement. The main tasks that were set are:

– to study the effect of weed control measures on biological communities of weeds in grape agrophytocenoses;

– to determine the impact of technological control measures on the dynamics of weeds/thistle population in industrial grape plantations.

The aim of the study is to perform objective analysis of the effectiveness of technological measures for controlling the development of pink and gray thistle among industrial grape plantations, taking into account their characteristics and modern control measures.

Presentation of the main research material. The study of the peculiarities of the development and formation of the number of pink thistle plants, depending on the measures for regulating the number and development of weeds, was carried out on the plantations of the Bianca variety, laid out according to the scheme of 3x1.25 m. The plants of the experimental plot were formed by a two-tier cordon with a bole height of 1.2 m. The study of the dynamics of formation of the number and mass of pink thistle in vineyards was carried out in the areas with soil maintenance under the current technology of fallow land (control) and winter rye and sour sorrel crops with periodic mowing. The grown green mass of intercrops (winter rye and sour sorrel) was left on the soil surface as mulch.

Studies have shown that two plants that are very similar in biology and morphological characteristics are pink thistle (Cirsium arvense) and gray thistle (Cirsium incanum Fisch), with a ratio of 1:3. The gray thistle is distinguished by a strong white-felted pubescence of leaves and stems. Plants of pink thistle are almost bare or have slightly cobweb-like moss. In addition to external morphological features, these two species differ in the structure and predominant development of the root system. In pink thistle, the depth of penetration of the root system reaches 4–6 m, and in areas with a shallow water table of 30–50 cm it does not reach the level of groundwater. The bulk of gray thistle roots mainly develop in the 30–50 cm soil layer.

The initial penetration of pink and gray thistles into vineyards is provided by seeds, and in the future the weeds spread extremely quickly due to the buds formed on horizontal roots. Despite the biological characteristics of the growth and development of pink and gray thistles, the structure of their root system, they often create a monospecies grouping, from which all other species of weed synusia are displaced, and compete quite successfully with grape bushes and many types of weed phytocoenosis for moisture and nutrients. Soil temperature is the regulator of germination of the vast majority of weeds in vineyards, especially thistles.

Therefore, during the calendar year, three periods of formation of segetal communities with the participation of thistles are conditionally distinguished in vineyards with fallow lands: 1) spring, after the temperature passes through +5°C; 2) during the active vegetation of grape bushes; 3) autumn-winter, which begins after the harvest of berries, includes the winter period and continues until the air temperature passes through +5°C in spring. These periods differ in environmental (timing, thermal and water conditions, solar insolation, etc.) and phytocoenotic conditions (lack of competition from grapes, very little shading). Under these objective circumstances, weed communities, the so-called chronosynusia, are formed differing in species composition and number. This development of segetal vegetation is also facilitated by the lack of appropriate measures for controlling weed infestation during this time, which results in the formation of a large number of weeds in the period from the end of the vegetation of the bushes of the previous year to the beginning of the growth stage of grape shoots in the spring of the next year (Table 1).

Every year, at the initial stage of grape development, the composition of biological and cenotic weed communities includes many species, in which the proportion of perennial plants ranges from 19.7–28.2%, depending on the terms of cultivation of plantations, stocks of vegetative reproduction organs and technological measures for controlling the number and development of segetal vegetation. In addition, the number and timing of perennial weeds depends on environmental conditions, including water and thermal conditions, and solar energy intake.

Table 1

Effect of weed control measures on biological communities of weeds in grape agrophytocenoses (the stage of grape sap flow, % to the number of species of biological and phytocoenotic community)

Plantation weed control measures	Biological communities of weeds					
	1	2	3	4	5	6
chemical and mechanical, control	28,3	31,6	-	9,3	11,1	19,7
cultivation of sour sorrel in the row spacing of grapes	22,1	15,4	-	17,8	16,5	28,2
cultivation of winter rye in the row spacing of grapes	15,4	17,3	-	20,7	19,0	27,6

1 – ephemerals; 2 – early spring; 3 – late spring; 4 – wintering; 5 – optional and true biennials; 6 – perennials.

Every year, at the initial stage of grape development, the composition of biological and cenotic weed communities includes many species, in which the proportion of perennial plants ranges from 19.7–28.2%, depending on the terms of plantation cultivation, stocks of vegetative reproduction organs and technological measures for controlling the number and development of segetal vegetation. In addition, the number and timing of perennial weeds depends on environmental conditions, including water and thermal conditions, and solar energy intake.

Under satisfactory water and heat conditions, pink and gray thistles appear in vineyards in autumn, spring, and throughout the summer growing season. Late autumn thistle seedlings develop to the 2–3 leaf stage and die with the onset of frost. August thistle seedlings are more resistant to unfavorable wintering conditions, especially if they developed under satisfactory water and thermal conditions. In spring, the first seedlings of pink and gray thistles appear from seeds caused by the high temperature of the upper 0–3 cm soil layer with a number of about 9–12 pcs./m^2. In terms of calendar time, the emergence of seedlings from the seeds of pink and gray thistles, the subsequent formation of leaf rosettes coincides with the stage of grape sap flow. Due to the unstable weather conditions of this period, pink and gray thistles, having formed a rosette of leaves with a diameter of 2–3 cm, grow and develop very slowly.

The subsequent removal of cut shoots from the vineyard rows, the first tillage and the application of Roundup herbicide locally, along the axis of the row of bushes, along with other types of weeds, destroys almost all young plants of pink and gray thistles that started developing from seeds. New seedlings of pink and gray thistle, from the buds of perennial rhizomes, begin their growth much later, after reaching a temperature of 8–10°C at a depth of 20–30 cm, and most often observed at the end of the third decade of April or in the first decade of May, which almost coincides with the beginning of the growth stage of grape shoots. The delay in the beginning of the development of thistle rhizomes excludes the phytotoxic effect of the applied herbicide, as a result of which these plants determine their number in the weed community and potential harmfulness.

At the initial stage, the development and formation of multi-tiered rosettes of pink and gray thistle is slow, but later, with the improvement and stabilization of the thermal regime, it is significantly accelerated, which contributes to the intensive formation of aboveground vegetative mass of plants. The beginning of the intensive growth and development of pink and gray thistles coincides with the beginning of the grape berry growth stage and continues until the end of the harvest ripening, and very often after harvesting. The intensive growth and development of thistles is also facilitated by the absence of weeds, or their small number, which reduces competition for mineral resources, moisture, and solar energy.

Registration of the number and development of weeds conducted at the end of the stage of grape shoot growth in the areas with fallow land showed that the frequency of spread of pink and gray thistle plants in different biological and cenotic communities reached 53.1–57.4% with an average number of 3.4–3.7 pcs/m^2, which developed along the axis of a row of bushes and a protective strip.

Outside of this sector, the number of pink and gray thistle plants did not exceed 1–2 pcs/m^2, which were suppressed in development due to regular mechanical destruction of rosettes in the process of soil cultivation in this sector of row spacing. The difference in the number of pink and gray thistle plants is also due to different depths of tillage, which is shallower in the sector of the axis of the row of bushes and deeper beyond it. The conditions in different sectors of the row spacing also change the frequency of pink and gray thistles. Along the axis of the row of bushes and the protective strip, pink thistle plants prevailed in number and development. The frequency of spread of gray thistle plants did not exceed 23–27% with the number of 1–2 pcs/m^2, in the form of rosettes of 3–5 leaves depressed in development (Table 2).

Table 2

Influence of technological control measures on the dynamics of weeds/thistle in industrial grape plantations

Technological measures for weed control	Dynamics of the number of weeds/sedge, pcs/m^2					Average number of weeds/thistle pcs/m^2
	stages of grape growing season					
	1	2, 3	4	5	6	
chemical and mechanical	42,6/3,7	16,2/2,9	12,6/2,7	8,3/2,5	23,1/2,8	23,9/2,7
cultivation of sour sorrel	51,2/3,4	48,3/5,5	27,5/3,6	20,7/3,4	31,4/3,3	37,8 /3,8
growing winter rye	27,4/2,9	49,5/2,1	31,5/2,0	18,5/2,3	27,2/2,3	31,0/2,3

The lower number of gray thistle and its inhibited development are due to the predominant development of the root system in a highly compacted horizon of 0–30 cm, the rapid formation of moisture deficit in this soil layer, and the increased competition for moisture consumption by grapes and other weed species. Pink thistle is more adapted to unfavorable growing conditions among grapes, so it develops more quickly, and already in the middle of the berry growth stage it forms a stem 35–40 cm high, and by the end of the stage it increases to 60–75 cm. With an average number of pink thistle plants in the range of 2.5–2.7 pcs/m^2, during the growth-ripening stage of berries, its vegetative mass reaches 250–270 g/m^2.

The general tendency of pink thistle development and growth of its number in the second half of the growing season is determined by soil moisture conditions. With sufficient moisture reserves, the number of thistle plants increases due to sprouting from seeds and underground rhizomes.

The cultivation of intercrops, such as winter rye and sour sorrel, between grape rows causes qualitative and quantitative changes in the species composition, number and development of weeds, including perennial weeds such as pink and gray thistles.

Changes in the number, intensity of development and formation of the vegetative mass of thistle plants, their share in the formation of total weediness were observed only within the local area occupied by intercrops. Depending on the biological characteristics of the grown intermediate crops, their influence on the formation of the number and development of pink and gray thistles differed in time and consequences.

Sour sorrel, in the first half of the year after sowing, develops and increases the vegetative mass of leaves very slowly, and therefore has almost no significant effect on the development of pink and gray thistle seedlings at this time. This is also facilitated by the soil cultivation regime of this area, its temporary absence. Due to this, pink and gray thistles, at the initial stage of the joint vegetation, increase their number, successfully competing with sour sorrel, often outstripping it in development. Intensive growth of sour sorrel leaves mass, formation of its significant area begins in the second half of the grape growing season, but acute soil moisture deficit negatively affects plants, which limits its influence on the growth, development and formation of the vegetative mass of pink and gray thistle.

The conditions for the development of pink and gray thistle in the environment of winter rye also depend on many factors, such as sowing time, soil moisture reserves, temperature, plant density and development. Under optimal environmental conditions, winter rye seeds germinate 6–8 days after sowing. In autumn, seedlings of pink and gray thistles appear mainly from seeds, and in the environment of winter rye they start developing later, on average by 3–5 days, and form a rosette with 2–3 leaves with a diameter of 1–3 cm and a number of 3.1–2.9 pcs/m^2. Further development of thistle seedlings is determined by the condition of winter rye. In the presence of 600–650 well-developed winter rye plants, the intensity of solar energy flow in their environment decreases to minimum values, as a result of which thistle seedlings stop growing and die in winter. With a lower density of winter rye plants or their depressed state, the growing conditions of a significant part of thistle seedlings are significantly improved, resulting in an increase in the area of the rosette leaves, a greater mass of roots, and a greater depth of their penetration into the soil. Most of these plants can withstand unfavorable wintering conditions and replenish the thistle population in the following spring.

Thus, the vegetation of pink and gray thistle plants can last for almost 9 months, which allows them to achieve maximum development, ensure maximum seed productivity, and replenish the nutrient reserves of perennial rhizomes during this time.

Conclusions. Thus, as a result of the conducted research, it was found that modern agrotechnical measures for controlling pink and gray thistle are mainly based on the depletion of the root system by systematically cutting the rosettes of the weed to prevent the formation of a rosette of leaves on the soil surface. For this purpose, the vineyard soil is traditionally kept fallow, with multi-depth tillage during the grape growing season. However, even after the full implementation of such agrotechnical measures, it is not possible to completely destroy the well-developed root system of pink thistle, and the measure requires large expenditures of man-made energy. In this regard, a radical reassessment of technological measures for controlling the number and development of pink and gray thistles is needed. The most promising for reducing costs and achieving maximum efficiency in the fight against pink thistle is the integrated application of agrotechnical, phytocoenological and chemical measures, with the obligatory consideration of the biological characteristics of the weed development.

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