
USE OF PLANT-BASED BIOPREPARATIONS TO PROTECT GRAIN CROPS FROM FUNGAL INFECTIONS

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Summary

The article discusses the efficiency of using plant-based biopreparations to protect grain crops from fungal diseases in Serbia. Screening of medicinal plant extracts (*calendula officinalis*, yarrow, tansy and wormwood) for their fungicidal properties was conducted. It was found that seed treatment with 2% aqueous extracts reduces plant infestation by fungi of the genera *Alternaria*, *Fusarium* and *Bipolaris*, which helps to increase crop resistance to diseases. Field experiments showed an increase in the yield of spring wheat of the BG Unigold variety when using plant extracts. The highest biological efficiency was found in yarrow and wormwood extracts, which reduced the spread and development of root rot. The study proved the prospects of using plant-based preparations as an environmentally friendly alternative to chemical pesticides.

Key words: biopreparations, plant extracts, fungicidal activity, grain crops, fungal diseases, alternative pesticides, ecology, crop yield.

Introduction. Protection of grain crops from fungal diseases is one of the key tasks of agriculture, especially in the conditions of Serbia, where such diseases as *alternaria*, *fusarium* and *helminthosporiosis* are widespread. Traditional methods of control include the use of chemical fungicides, but they can have a negative impact on the environment and human health. In this regard, the urgent task is to find alternative environmentally friendly methods of plant protection. Biopreparations of plant origin are a promising direction in phyto-protection, since they have natural fungicidal properties, stimulate the defense mechanisms of plants and do not accumulate in agrocenoses. The purpose of this study is to study the effectiveness of using

plant extracts in protecting grain crops from fungal pathogens.

Many higher plants are characterized by a high content of biologically active compounds that can act as stimulants of physiological and biochemical processes or inhibitors, antibiotics, fungicides. Recently, extracts from some plants have begun to find application as biological means of protection against phytopathogenic fungi.

The mechanism of protective action of plant extracts has not been fully studied. It is assumed that, on the one hand, they have a toxic effect directly on the pathogen [1-3], and on the other hand, they stimulate the protective reactions of the host plants [1,4]. For example, it has been shown that treatment of cucumbers with extracts of *Reynoutria sachalinesis* leads to an increase in the activity of such enzymes as peroxidase, polyphenoloxidase, chitinase, β -1,3 glucanase [1], and after infection, the content of phytoalexins in plant leaves increases sharply [5]. The effect of crude extracts and essential oils of *Calendula officinalis*, yarrow, *Eucalyptus citriodora*, and *Ageratum conyzoides* on spore germination and mycelial growth of *D. bryoniae* was studied in vitro. Essential oils of *C. citratus*, *A. conyzoides*, and *E. citriodora* completely suppressed mycelial growth and spore germination of the fungus. Under the influence of *A. millefolium* oil, the nature of pathogen hyphae growth changed [6]. Currently, there is a lot of information in the literature on the effect of plant-based biopreparations on pathogenic microflora, but research in this promising area does not go beyond laboratory testing. Systematic research is needed to obtain and use phytopreparations in sexual experiments as an alternative to chemical pesticides, which is especially important for Serbia, where the most important agricultural crops are grains. Unfortunately, their mass defeat from fungal dis-

eases - alternaria, gel mintosporiosis and fusarium leads to an increase in the amount of chemical protection products used.

Materials and methods. The studies were conducted in 2023–2024 in the field and laboratory conditions. For seed treatment, 2% aqueous extracts of the following plants were used:

- calendula officinalis,
- yarrow (*Achillea millefolium*),
- tansy (*Tanacetum vulgare*),
- wormwood (*Artemisia absinthium*).

Laboratory studies included mycological analysis of seeds and plant tissues to identify pathogens of the genera *Alternaria*, *Fusarium* and *Bipolaris*. Field trials were conducted on crop areas using spring soft wheat of the BG Unigold variety. The experiment included four replicates, the control variant was treated with water. The effectiveness was assessed based on the following indicators:

- percentage of plants affected by fungal diseases,
- biological and economic effectiveness,
- yield (weight of 1000 grains, number of grains in an ear).

In order to find environmentally friendly means of protection, screening of higher plants was conducted to study antifungal properties [7, 8]. A study of the fungicidal activity of extracts from wild typical representatives of the flora of Serbia showed that plant extracts of *Achillea millefolium*, *Cymbopogon Hot o* (*Achillea millefolium*), common tansy (*Tanacetum vulgare*) and bitter wormwood (*Artemisia adsinthium*) oils have a pronounced fungistatic effect and inhibit the growth and development of colonies of the studied micromycetes, expressed in the lysis of aerial and substrate mycelium at the early stages of their development. For comparative assessment. To determine the effectiveness of these extracts, field experiments were conducted to study the spread and development of fusarium-helminthosporium root rot and alternaria of wheat seeds [9, 10]. The experiment was repeated four times, the placement of plots was randomized. The size of the plots was 1 ml. The variety of spring soft wheat was BG Unigold, the seeding rate was 300 pcs./m². Seed treatment with 2% aqueous extracts of plants was carried out a day be-

fore sowing. The control variant was treated with water. Wheat seeds treated with aqueous extracts of the noted plants were sown into the soil.

Results and discussion. Mycological analysis showed that seed treatment with plant extracts reduced seed infestation by pathogenic fungi by 40–52%. The highest efficiency was demonstrated by yarrow and wormwood extracts, which inhibited the spread of *Alternaria* and *Fusarium*. In the field, a reliable increase in yield was noted in the variants with treatment with plant extracts. The weight of 1000 grains in the variants with calendula and tansy exceeded the control by 2.6–2.9 g, and the productive tillering in the variant with yarrow was higher than the control value.

The biological efficiency of plant extracts averaged 32.2% in 2023 and 45.2% in 2024, which confirms their fungistatic effect. The highest level of economic efficiency was recorded in the variants with seed treatment with wormwood and yarrow, where the increase in yield was 5.2 c/ha compared to the control.

According to the results of the analysis of the elements of the 2023 crop structure, seed treatment with plant extracts did not affect the height of the plants, the length of the spike and the number of spikelets in the spike. The productive tillering of plants treated with extracts of common yarrow was higher than in the control. The plant extract of common tansy stimulated the formation of grain in the spike. In this variant, the number of grains in the spike and the weight of 1000 grains exceeded the control indicators.

According to the 2024 data, a reliable increase in the number of grains in the spike was noted in the variants with seed treatment with extracts of tansy and yarrow. On average, the number of grains in the spike was 36.7 and 38.2 pcs., respectively. Treatment of wheat seeds with calendula and tansy had a positive effect on the weight of the grains. The weight of 1000 grains in these variants exceeded the control by 2.6–2.9 g.

The results of our studies of mycological analysis of the affected tissue of the root zone and the first internode of the stem, as well as seeds, presented below, allow us to identify the main representatives of patho-

Table 1. Infection of seeds, root zone and first internode of wheat plants of the BG Uni-gold variety by pathogens of fungal diseases depending on seed treatments with plant extracts.

Option	Seed infestation, %	Including by birth, %			Infestation of the root zone and first internode with pathogens 6%		
		<i>Alternaria</i>	<i>Fusarium</i>	<i>Bipolaris</i>	<i>Alternaria</i>	<i>Fusarium</i>	<i>Bipolaris</i>
Control	87,0	83,8	11,2	5	18,1	69,2	12,6
Yarrow	34,2	37,5	28,5	40,0	37,8	37,3	24,8
Tansy	40,3	61,8	38,2	0	10,0	60,0	30,0
Calendula	36,1	90,5	9,5	0	10	77,5	12,5
Wormwood	46,7	88,2	11,8	0	31,3	35,8	32,9

Table 2. Efficiency of plant extracts of higher plants against root rot of wheat, 2023-2024.

Option	Yield, %		Disease development, %		Biological efficiency, %		Economic efficiency, %	
	2023	2024	2023	2024	2023	2024	2023	2024
Control	188	218	22,3	34,2	-	-	-	-
Yarrow	256	272	10,6	14,1	52,6	58,7	26,5	19,8
Tansy	203	240	17,4	19,9	21,9	41,8	7,4	9,1
Calendula	268	279	20,3	21,3	8,9	37,7	29,8	21,8
Wormwood	280	293	12,2	19,6	45,3	42,6	32,8	25,6
On average	239	260	16,5	21,8	32,2	45,2	24,1	19,1

genic fungi and the role of plant extracts in reducing the infectious origin (Table 1).

Treatment of seeds with plant extracts reduced the infestation of seeds with pathogenic fungi by 40-52%. Mycological analysis of seeds showed that wheat seeds were mainly affected by fungi of the genus *Alternaria* - the causative agents of alternaria seed blight. The seed infestation by fungi of the genus *Alternaria* was 37-90%. Seed treatment with an extract of yarrow contributed to the inhibition of the spread of alternaria pathogens.

Fusarium seeds were found in very small quantities in the variant with seed treatment with an extract

Fungi of the genera *Fusarium*, *Bipolaris*, and *Alternaria* were isolated from the affected sections of the root zone and the first internode of the stem of the BG Uni-gold wheat plant variety. *Fusarium* root rot pathogens predominated, the percentage of fungi of the genera *calendula officinalis* and *Fusarium* was on average 56%.

The infestation of wheat plants with root rot is characterized by their spread and

development. In 2023, the spread and development of wheat root rot was observed throughout the growing season. Despite this, by the stage of full maturity, a decrease in the noted indicators was noted in the variants where the seeds were treated with plant extracts. Plant extracts of common yarrow and wormwood especially contributed to a decrease in the spread and development of the disease (Table 2). In these variants, the number of healthy plants was 65-67%.

In the practice of agrobiological work, the most significant criteria in matters of using preparations of various origins are such indicators as biological and economic efficiency. Biological efficiency averaged - 32.2% in 2023 and 45.2% in 2024. The highest biological efficiency was found in areas where seeds were treated with yarrow and wormwood. The economic efficiency of treating wheat seeds with wormwood extracts was the highest, in some cases reaching 32.8%. In general, treating wheat seeds with plant extracts suppressed pathogenic microflora, increased resistance to fungal diseases and the yield of this crop.

Conclusion. Ecological aspects of practical application of plant-based biopreparations in crop production provide favorable ecological focus based on exclusion of chemical means of protection, showing growth-stimulating and protective properties, contributes to improvement of phytosanitary condition of agrocenoses, stabilization of self-regulatory processes in ecosystems, as well as obtaining ecologically safe agricultural products with a high level of economic efficiency.

The results of the study confirm the effectiveness of plant biopreparations in protecting grain crops from fungal diseases. The use of extracts from yarrow, tansy, calendula and wormwood reduces the infestation of plants by phytopathogenic fungi, increases productivity and can become an ecologically safe alternative to chemical fungicides. Further research should be aimed at identifying optimal dosages and mechanisms of action of plant extracts in various agroclimatic conditions.

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**Дәнді дақылдарды саңырауқұлақ
инфекцияларынан қорғау
үшін өсімдік негізіндегі
биопрепараттарды қолдану**

Аңдатпа

Мақалада Сербияда дәнді дақылдарды саңырауқұлақ ауруларынан қорғау үшін өсімдік биопрепараттарын қолданудың тиімділігі қарастырылған. Дәрілік өсімдіктердің (дәрілік қырымызгүл, мыңжапырақ, пижма және жусан) сығындылары олардың фунгицидтік қасиеттері бойынша скринингтен өтті. Тұқымдарды 2% сулы сығындылармен өңдеу *Alternaria*, *Fusarium* және *Bipolaris* тектес саңырауқұлақтардың ауруын азайтатыны анықталды, бұл дақылдардың ауруларға төзімділігін арттыруға көмектеседі. Өсімдік сығындыларын пайдаланған кезде BG Unigold сортының жаздық бидайының шығымдылығының артқанын далалық тәжірибелер көрсетті. Ең үлкен биологиялық тиімділік тамыр шірігінің таралуы мен дамуын төмендететін мыңжапырақ пен жусан сығындыларында табылды. Зерттеу химиялық пестицидтерге экологиялық таза балама ретінде шөптік препараттарды қолдану мүмкіндігін көрсетті.

Түйінді сөздер: биопрепараттар, өсімдік сығындылары, фунгицидтік белсенділік, дәнді дақылдар, саңырауқұлақ аурулары, балама пестицидтер, экология, дақылдардың өнімділігі.

Материал баспаға 03.11.24 түсті

**Использование биопрепаратов
растительного происхождения
для защиты зерновых культур
от грибных инфекций**

Аннотация

В статье рассматривается эффективность применения растительных биопрепаратов для защиты зерновых культур от грибных болезней в условиях Сербии. Проведен скрининг экстрактов лекарственных растений (календулы лекарственной, тысячелистника обыкновенного, пижмы обыкновенной и полыни горькой) на их фунгицидные свойства. Установлено, что обработка семян 2%-ными водными вытяжками снижает пораженность растений грибами родов *Alternaria*, *Fusarium* и *Bipolaris*, что способствует повышению устойчивости культур к заболеваниям. Проведенные полевые опыты показали увеличение урожайности яровой пшеницы сорта BG Unigold при использовании растительных вытяжек. Наибольшая биологическая эффективность выявлена у экстрактов тысячелистника и полыни, которые снижали распространение и развитие корневой гнили. В результате исследования доказана перспективность использования растительных препаратов в качестве экологически безопасной альтернативы химическим пестицидам.

Ключевые слова: биопрепараты, растительные экстракты, фунгицидная активность, зерновые культуры, грибные болезни, альтернативные пестициды, экология, урожайность.

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