THE IMPACT OF BIOTIC AND ABIOTIC STRESSORS ON PULSE CROPS IN THE REPUBLIC OF MOLDOVA

CÎRLIG Natalia, IURCU-STRĂSTARU Elena, ȚÎȚEI Victor, BIVOL Alexei, GUȚU Ana

Abstract. Edible legume species Fabaceae family, in the Republic of Moldova, are universal crops due to their diverse agro-industrial and zootechnical uses. These advantages are associated with the bio-ecological adaptations to biotic and abiotic factors, which include such phenomena as drought and heat waves as well as pest complexes. Phenological and phytosanitary surveys were conducted on such legume species, pulse crops as: pea (*Pisum sativum*), soybean (*Glycine max*), common bean (*Phaseolus vulgaris*), faba bean (*Vicia faba*), white lupine (*Lupinus albus*), chickpea (*Cicer arietinum*) and lentil (*Lens culinaris*), under the impact of pest complexes, under the conditions of experimental sectors in open field. Some phenological features of the investigated species were identified and some of the most common pest species associated with the respective crops were estimated. The most resistant species to the parasitic and pathological impact are *Pisum sativum* and *Vicia faba*, since they are early-season crops, they avoid the critical contamination phases, but the most vulnerable species were *Glycine max*. and *Phaseolus vulgaris*, which were more severely affected by *Bruchus* sp., *Ascohyta* spp., and various bacterial diseases in the budding and flowering stages. Besides, the severity of the impact of pedological drought, as well as parasitic, entomological and pathological impact was determined comparatively by species.

Keywords: Fabaceae species, biological survey, phytosanitary impact, pulse crops.

Rezumat. Impactul unor factori biotici și abiotici de stress asupra culturilor leguminoase pentru boabe în condițiile Republicii Moldova. Speciile de leguminoase comestibile pentru boabe din familia Fabaceae, din Republica Moldova, sunt culturi universale datorită diverselor utilizări agro-industriale și zootehnice. Aceste avantaje sunt asociate cu adaptările bio-ecologice la factorii biotici și abiotici, care includ fenomene precum seceta și valurile de căldură, precum și complexele de dăunători. Cercetările fenologice și fitosanitare au fost efectuate la specii de leguminoase pentru boabe precum: mazărea (*Pisum sativum*), soia (*Glycine max*), fasolea comună (*Phaseolus vulgaris*), bobul (*Vicia faba*), lupinul alb (*Lupinus albus*), năutul (*Cicer arietinum*) și lintea (*Lens culinaris*), sub impactul complexelor de dăunători, în condițiile sectoarelor experimentale în câmp deschis. Au fost identificate unele caracteristici fenologice ale speciilor investigate și au fost estimate unele dintre cele mai comune specii de dăunători asociate culturilor respective. Cele mai rezistente specii la impactul parazitar și patologic sunt *Pisum sativum* și *Vicia faba*, fiind culturi timpurii, evită fazele critice de contaminare. Cele mai vulnerabile specii au fost *Glycine max*. și *Phaseolus vulgaris*, care au fost mai grav afectate de *Bruchus* sp., *Ascohyta* spp. și diverse boli bacteriene în stadiile de înmugurire și înflorire. În plus, severitatea impactului secetei pedologice, precum și impactul parazitar, entomologic și patologic a fost determinate comparativ pe specii.

Cuvinte cheie: Fabaceae, studiu biologic, impact fitosanitar, leguminoase comestibile pentru boabe.

INTRODUCTION

Global climatic change combined with population growth is imposing a huge pressure on demand for food and forage resources. The family Fabaceae Lindley (*Papilionaceae* Giseke, *Leguminosae* Juss.) is part of the order Fabales (Leguminosales) of dicotyledonous flowering plants. It is a large family, which includes about 400 genera and over 9000 species of annual and perennial herbaceous plants, shrubs and trees. The species in this family are characterized by compound leaves, rarely simple, with stipules. The flowers are papilionaceous, that is – have butterfly-like corolla, zygomorphic, pentamerous; the fruits are polyspermous pods. In Bessarabia, 146 species of 35 genera occur naturally (IZVERSCAIA, 2020).

Some data from the specialized literature indicate that legumes have been used since over 5000 years B.C., by the inhabitants of the current territory of Switzerland, who cultivated pea, chickpea and other legume species for their grains. There is also evidence that, in China, soybean was cultivated around 3000 years B.C. (ZAMFIRESCU et al., 1965).

The Fabaceae species are of great ecological importance due to their symbiotic relationship with nitrogen fixing bacteria *Bradyrhizobium japonicum*, *Rhizobium ciceri*, *Rhizobium phaseoli*, *Rhizobium Ieguminosarum*, *Rhizobium meliloti*, *Rhizobium trifolii*, microorganisms capable of transforming atmospheric nitrogen into fixed nitrogen usable by plants (DASHORA, 2011).

The Fabaceae plants species are currently in high demand due to their edible fruits and seeds with high content of protein, but being all from the same botanical family, included in various genera, these species also have certain common morpho-biological, physio-ecological and agro-technological characteristics, which represent them in several agrobiological aspects. The exceptional importance and popularity of leguminous crops is mostly due to the use of their grains in food namely as a rich source of protein, offering them a major nutritional value, and some species such as soybeans and peanuts also contain a significant amount of vegetable oil, being also valuable as oleaginous plants. Soybean is the leading oilseed crop in the world and peanut ranks third, being surpassed by sunflower. Many *Fabaceae* species are valuable food, forage and cover crops, medicinal melliferosus plants, excellent organic raw materials for circular economy (DUKE, 1992; LEWIS et al., 2005; ROMAN et al., 2011; LUSCHER et al., 2013; STODDARD, 2013; STINNER, 2015; TELEUȚĂ et al., 2015; FOSTER et al., 2021; ȚÎȚEI, 2020, 2021, 2022ab; PETCU et al., 2022; COȘMAN et al., 2023; ȚÎȚEI & COZARI, 2023). The interest in systems based on legumes species has increased significantly over the recent

years in the European Union due to their importance for sustainable and organic farming. In the European Union, the interest in forage legumes has increased for several economic and environmental reasons (***. European Parliament resolution 2011, 2018; ECPGR 2021).

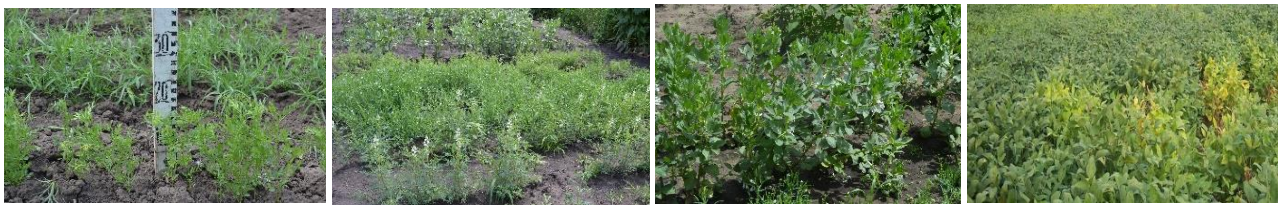
These advantages are due to the bioecological features of adaptation to the abiotic factors that ensure the thermal regime, the regulation of homeostasis and the induction of physiological resistance to thermal and water stressors and some harmful organisms mentioned in specialized sources such as: BUSUIOC (2006), BĂDĂRĂU & BIVOL (2009). Among the disadvantages of growing these crops, there is the impact of long droughts in the critical phases of germination – the formation of pods, as well as the attack of a large number of diseases and pests. These organisms annually cause serious diseases of these crops, stimulated also by environmental factors that are favourable not only for the development of the above-mentioned legumes, but also for the evolution of key disease and pest complexes (BĂRBULESCU et al., 2002; OROIAN & FLORIAN, 2006; BUSUIOC, 2006; BĂDĂRĂU & BIVOL, 2009; BĂDĂRĂU, 2012).

Based on the mentioned actualities, we have carried out research in this direction related to phytosanitary records carried out periodically on experimental plots and plantations of Fabaceae species, with the essential aim of establishing bioecological indices, which reflect the response of these crops to drought and the invasive attack of diseases and key pests.

The main motivation of the authors was to carry out research aimed at: bioecological and phytosanitary monitoring on legume species, pulse crops: pea (*Pisum sativum*), soybean (*Glycine max*), common bean (*Phaseolus vulgaris*), faba bean (*Vicia faba*), white lupine (*Lupinus albus*), chickpea (*Cicer arietinum*), lentil (*Lens culinaris*)species, under the conditions of experimental plots, establishing values that characterize the reaction of resistance to drought and key diseases associated with pests specific to these crops. Based on the actuality of the topic and the goal set by us, we have established the following objective for the research: making records of biological and phytosanitary control establishing the degree of hydrothermal and phytosanitary impact, highlighting the response reactions and the most invasive species of diseases and pests in the studied crop species.

MATERIAL AND METHODS

The research was carried out on the experimental sectors of the National Botanical Garden (Institute) "Alexandru Ciubotaru" Moldova State University during the growing seasons of 2023-2024, on experimental plots planted with annual of Fabaceae species: pea (*Pisum sativum*), soybean (*Glycine max*), common bean (*Phaseolus vulgaris*), faba bean (*Vicia faba*), white lupine (*Lupinus albus*), chickpea (*Cicer arietinum*), lentil (*Lens culinaris*). Subsequently, phenological records were made along with the establishment of the response reactions of plants to temperature and humidity, as well as the impact of diseases and pests detected in the experimental field. In the spring-summer period, maintenance works were carried out in the experimental sector to prevent weeds, to highlight the sensitivity of plants to unstable environmental factors, as well as to facilitate harvesting. At the same time, we also investigated some sectors planted with *Fabaceae* for grain production from various areas and phytotechnical production associations in the Republic of Moldova (Fig. 1).



a **b** **c** **d**

Figure 1. Experimental plots with various species of Fabaceae family:
a – lentil, b - white lupine, lentil, faba bean, c - faba bean; d – soybean (original).

Monitoring surveys were conducted to evaluate the process of plant growth and development in the dynamics of the phenological stages (the phenological study was conducted according to the guidelines in force (BEIDEMAN, 1974), phytosanitary records were made to identify the spectrum of diseases and parasitic entomological fauna. Visual observations, manual sample collecting, digital camera recordings and field notes were made which were later examined under laboratory conditions and compared with data from species identification guides and botanical and phytosanitary papers (***. METHODICAL GUIDELINES, 1997; OROIAN & FLORIAN, 2006; BĂDĂRĂU & BIVOL, 2009).

In order to determine the severity of the attack by diseases and harmful insects in the experimental and production sectors, plant samples were collected and analysed later both in the field and in the laboratory. Through phytosanitary research, the indices of frequency values (F%) and the intensity of the development of diseases and pests (I%) were established, determining the comparative impact on each species in the dynamics of growth and development.

RESULTS AND DISCUSSIONS

Under the conditions of the Republic of Moldova, geographically located in an area with unstable conditions in terms of temperatures and precipitation, often affected by droughts, it is more effective to cultivate some species of food

plants of the family Fabaceae in accordance with their bioecological requirements and response to such factors as heat, lack of precipitation and attacks of pests and diseases.

However, this cultivation system does not exclude the danger of weeds, instant outbreak of diseases and pests, negative reactions to drought and heat waves. The challenge of phytopathological, phytoparasitic and hydrothermal impact, including the damage caused by these factors to plants, is effectively determined by the instability of climatic factors (annual and seasonal), which make it difficult to prevent the appearance of pathogenic and parasitic agents. These factors seriously affect the plants and cause the premature drying of the leaves, stem brakage, necrosis and other damages that reduce or completely destroy the grain harvest.

These invasive associations detected on the researched plants are always in the attention of researchers, who frequently conduct significant investigations on this topic and are included among the research objectives that focus on the resistance and tolerance of plants to the instability of environmental factors. According to the analysis of bibliographic sources and our own research, annually, *Fabaceae* species are invaded by more than 25 pathogenic agents and parasitic insects, which, under unstable climate conditions (hydrothermal stress), cause specific diseases and damage to the plants, starting from the stage of seed germination in the soil. For this reason, annually, on the experimental plots of NBGI, in comparison with the Fabaceae sectors for grain production, we carry out a complex study on the response of plants to the spring-summer drought and their reaction to specific diseases and pests, with agro-economic importance. These conditions induce a decrease in the degree of plant resistance and consequently – to an increase in plant susceptibility to the attack of diseases and harmful insects. As a result of the physiological records of plants, in terms of their reaction to ambient temperatures, the investigated leguminous species have been categorized in 3 groups. The first, relatively more heat-demanding, includes pea and lupine. Under the conditions of the experimental sector, they germinated at a temperature of 5-6 °C (March 15-20), being also long-day plants, with very high humidity requirements.

The second group includes faba bean and chickpea, which in the respective year germinated at the beginning of April, because they require higher soil temperature as compared with the first group, within the limits of 6…9°C, the photoperiod is more favourable as the daylight length increases and the water demand is relatively lower. Common bean and soybean, which represent the third group, are the short-day species, thermophiles, less demanding to the photoperiod factor, but demanding to humidity, namely during the budding stage and the development of the pods with grains. The visual phenological analyses highlighted these comparative reactions, where the thermal threshold for germination varied among species, and here we noted that the earlier and most effective from agro-ecological point of view are pea and lupine. Faba bean and lentil need higher temperatures and more moisture at the germination – budding stages as compared with bean and soybean, which need higher temperatures with sufficient light and moisture at the stage of formation of side shoots (Figs. 2; 3). In the year of our research, on the experimental land and as a natural background, the sensitivity of the selected crops was estimated consecutively in all stages of vegetation, but significantly, especially in bean, soybean and lentil, there was a sudden decrease in the biological and agricultural yield because the long drought. The hydrothermal anomalies recorded particularly in the second half of the growing season (25.06-25.08), in the Republic of Moldova, affected heavily the formation of all phyto-technical productions.

Also in this context, the Fabaceae species were simultaneously evaluated for their response to some pathogens detected both on roots and on the aerial organs, causing various forms of rot, powdery mildew, ascochyta blight, anthracnose, septoria leaf spot, bacterial infections, downy mildew, rusts and various forms of viral mosaic diseases. All these Fabaceae species have been invaded by some associated complexes of harmful insects, such as the species of weevils, aphids, agriotes beetles, thrips, moths, midges etc. This pathological and parasitic impact was also triggered by the agro-climatic conditions of the Republic of Moldova during the investigation period (2023-2024), which were extremely favourable for the contamination, primary infection and the active and dynamic evolution and expansion of specific and common diseases of Fabaceae species associated with harmful insect species. In this context, we present the results of the preliminary and current phytosanitary surveys carried out on the experimental plots and productive sectors, where the diversity, pathogenic agents, parasites of the tested Fabaceae species are presented, with certain values of the frequency and intensity of attack estimated in the Table 1.

Analysing the data presented in Table 1, we would like to mention that from the spectrum of diseases detected according to the frequency and intensity of the attack, it has been estimated that the vegetative organs were affected the most, and several diseases had a major impact in the critical periods of plant development. The most severe impact was caused by the following pathogens: ascochyta blight – *Ascochyta spp*., powdery mildew – *Erysiphe pisum*, downy mildew – *Perenospora spp*., septoria leaf spot – *Septoria spp*., stem blight – *Diaporthe phaseolorum var. sojae*, with major values from 15% up to 40% degree of attack, varying among the tested species.

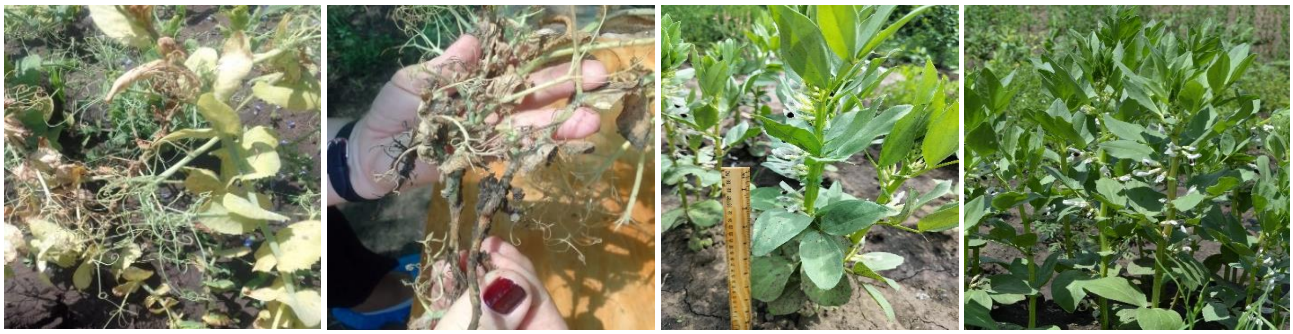
Table 1. The degree of attack of diseases and pests in the Fabaceae species investigated on the experimental plots of NBGI, 2024, Central area of R. Moldova.

Species	Disease / pest	Pathogen / parasite	Frequency, %	Intensity, %
Pea (*Pisum sativum*)	Powdery mildew	*Erysiphe pisi,*	30	26
	Downy mildew	*Peronospora pisi,*	26	22
	Rust	*Uromyces pisi,*	18	25
	Septoria leaf spot Anthracnose	*Septoria pisi,*	15	13
	Aphids	*Mycosphaerella pinodes*	34	30
	Weevils	*Acyrthosiphon pisum*	14	10

	Pea moth	*Sitonia lineatus,* *Bruchus pisorum* *Cydia nigricana*	18 28 12	15 24 8
Soybean (*Glycine max*)	Downy mildew Ascochyta blight Septoria leaf spot Powdery mildew Stem blight Pea weevil Pulse pod borer moth Agriotes beetles	*Peronospora manshurica Ascochyta sojaecola* *Septoria glycines* *Microsphaera diffusa* *Diaporthe phaseolorum var.sojae* *Sitonia liniatus* *Etiella zinckenella* *Agriotes spp.*	36 32 28 25 20 18 15 12	34 30 25 22 17 15 13 10
Common bean (*Phaseolus vulgaris*)	Ascochyta blight Rust Anthracnose Black rot Bean weevil Black bean aphid	*Ascohyta phaseoli* *Uromyces phaseoli* *Colletotrichum lindemuthianum* *Xanthomonas campestris pv phaseoli* *Acanthoscelides obtectus* *Aphis fabae*	40 38 32 25 20 18	37 35 30 23 17 15
Faba bean (*Vicia faba*)	Downy mildew Faba bean rust Root rot Aphids	*Perenospora fabae* *Uromyces viciae-fabae* *Fusarium oxysporum* *Aphis* spp.,	22 20 18 17	19 17 15 15
White lupine (*Lupinus albus*)	Downy mildew Powdery mildew Bean weevil Aphids Bean seed fly	*Perenospora lupinus* *Erisyphe lupinus* *Acanthoscelides obtectus* *Aphis fabae* *Delia platura*	23 25 20 15 10	20 22 17 13 7
Chickpea (*Cicer arietinum*)	Rust Chickpea blight Broadbean weevil Agriotes beetles	*Uromyces ciceri-arietini* *Mycosphaerella rabiei.* *Bruchus rufimanus ,* *Agriotes spp,*	18 20 15 15	15 17 12 12
Lentil (*Lens culinaris*)	Ascochyta blight Rust Root rot Bean weevil Aphids	*Ascophyta lens,* *Uromices lens,* *Fusarium oxysporum v. fabae* *Acanthoscelides obtectus,* *Aphis fabae*	25 18 15 18 15	23 15 12 14 13

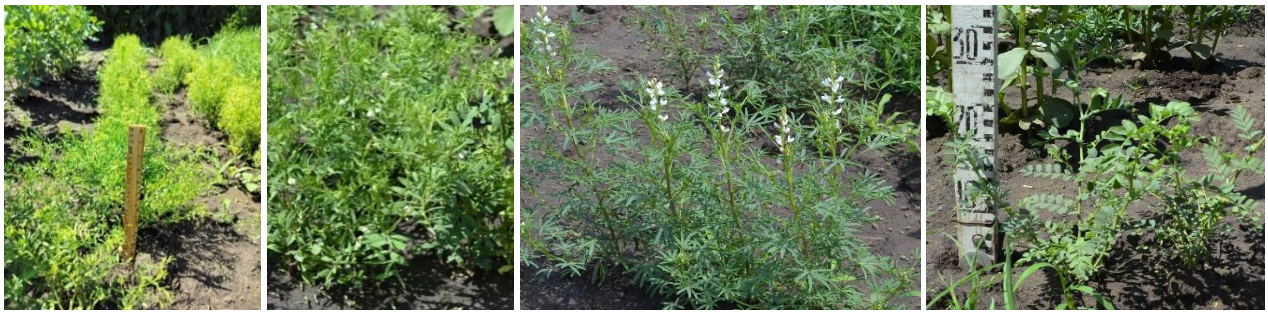
The species *Phaseolus* spp. and *Glycine max* were the most susceptible to diseases, being severely affected by ascochyta blight, powdery mildew and downy mildew. In this context, peas also stood out, being also very sensitive to powdery mildew, being affected up to 40% of the entire leaf surface. Along with diseases such as downy mildew, ascochyta blight, rust and septoria leaf spot, some diseases common for all the species of Fabaceae were also detected, for example powdery mildew, anthracnose, stem blight, root rot, which practically annually seriously contaminate the plants throughout the growing season. Besides, Table 1 shows the values of the records of entomological parasitic impact and expresses their association with the researched crops. The most dangerous and harmful pests attacking the plants and, therefore reducing the yields and causing economic losses, are the following: species of aphids – *Aphis fabae*, *Acyrthosiphon pisum*, weevils – *Sitonia lineatus, Bruchus pisorum, Bruchus rufimanus, Acanthoscelides obtectus* and moths – *Cydia nigricana, Etiella zinckenella*. This list also includes various species with a parasitic impact such as thrips, beetles, flies, wasps, bugs, which invade the mentioned plants, mainly in certain phases of vegetation, and attacking different plant organs, being favoured by certain environmental factors.

During our research, we found out that the successful management of the physiological and phytosanitary indices of harmful organisms, estimated in the investigations addressed, can be provided by applying a permanent physiological and phytosanitary control program elaborated specifically for the integrated protection of Fabaceae plants, which would include some means of controlling the number of pests, as well as the frequency and intensity of the degree of parasitic impact.



a b c d

Figure 2. Plants affected by multiple diseases: a, b – helminth infections associated with downy mildew and powdery mildew; c, d - faba bean plants with high tolerance to biotic factors (original).



a **b** **c** **d**

Figure 3. Leguminous plants in experimental plots: a, b – lentil plants in different phenological stages; c – lupin; d – chickpea (original).

CONCLUSIONS

The results of the physiological and phytosanitary research conducted on 7 species of the Fabaceae family, in 2023-2024, revealed the eco-physiological indices of the response of the studied plants to the impact of the unstable climate factors. The research also resulted in the elucidation of the diversity, the frequency and the intensity of the diseases caused by various pathogens and the pests affecting the researched plant species.

The monitoring surveys made it possible to establish the sensitivity of the investigated Fabaceae plant species to the impact long periods of drought. Thus, the species *Phaseolus* spp. and *Glycine max* were found to be the most vulnerable under the impact of environmental factors.

The diversity and severity of the detected plant diseases were analysed comparatively by species. Thus, 26 pathogens with specific etiology and symptoms for each of the 7 Fabaceae species were identified. The most damage was caused to the species *Faseolus* spp. and *Glycine max* – up to 40% degree of attack by ascochyta blight (*Ascochyta* spp.), followed by powdery mildew, downy mildew, anthracnose and rusts.

The monitoring and sampling activities revealed the presence of 8 species of parasitic insects, which also caused considerable damage to Fabaceae plants. These pests affected mostly the generative organs of plants. The most common pests were aphids – *Aphis fabae*, *Acyrthosiphon pisum*, weevils – *Sitonia lineatus, Bruchus pisorum, Bruchus rufimanus, Acanthoscelides obtectus* and moths – *Cydia nigricana, Etiella zinckenella*, which irrespective of the influence of environmental factors (namely – the water supply) invaded the plants in the critical stages of growth and development.

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