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Analysis of Physiological and Biochemical Characteristics of Local Soybean Varieties which were Artificially Damaged with Phytopathogenic Fungi

Hilola Matniyazova
Academy of Sciences of Uzbekistan

Utkir Yuldashev
Academy of Sciences of Uzbekistan

Dano Karshibayeva
Academy of Sciences of Uzbekistan

Marifat Salohiddinova
Academy of Sciences of Uzbekistan

Abstract: According to the analysis of the results of the amount of chlorophyll "a" and "b" in the leaves of local soybean varieties under the influence of phytopathogenic micromycetes during the budding period was found that the chlorophyll "a" and chlorophyll "b" index of all soybean varieties decreased compared to the control. This situation indicates that the amount of chlorophyll "a" and chlorophyll "b" in the leaves of soybean plants is related to the presence of phytopathogenic micromycetes. When studying the effect of micromycetes *F. oxysporum* on the content of chlorophyll "b" in soybean leaves, the least effect was found in varieties Tomaris and Genetik-1 (respectively, the difference from the control = -9.3 and -9.6), and the local variety Sochilmas had the strongest influence (respectively, it showed that the difference from the control = -56.6 and -61.1). When studying the effect of micromycetes *A. alternata* on the amount of chlorophyll "b" in soybean plant leaves, the variety Genetik-1 had the least effect (respectively, the difference from Control = -15.4 and -14.3), and the strongest effect was on varieties Nafis and Sochilmas (respectively differences from control = -41.6 and -38.2).

Keywords: Soybean, Budding period, Flexibility, Chlorophyll, Phytopathogenic, Disease, Control, Experimental, Physiological.

Introduction

Soybean is one of the most important agricultural crops to meet the food demand of the world population. Soybean grains contain 18-24% fat, 36-40% protein, 26-34% carbohydrates, and 5-8% minerals (Arioglu, 2014). Legumes are highly valued worldwide as a low-cost alternative to meat and are the second most important food source after cereals. Legumes have a high nutritional value, providing people with proteins, essential amino acids, complex carbohydrates, minerals and vitamins (Maphosa, 2017). Soybean (*Glycine hispida Max (L.)*, or "golden bean"), which is considered a representative of this family, is an important plant on earth for its use in food and animal husbandry (Alexander, 1974).

Today, one of the main problems in all soybean-growing countries of the world is a contamination of soybeans with phytopathogenic micromycetes, which significantly damages the yield of this crop. 26-30% of the crop is lost due to various diseases and external stress factors in soybean, like other crops worldwide (Oerke, 2004). So far, more than 30 diseases caused by fungi, bacteria, and viruses have been identified in soybean (Ranjan, 2019).

One of the most economically damaging diseases of leguminous plants is wilt disease caused by *fusarium* species. Many legume-growing countries suffer from this disease, which also affects the roots of the plant and causes the loss of a large part of the crop (Sampaio, 2020). More than 135 microorganisms have been studied in the soybean plant, but about 30 of them, mainly fungi, bacteria, and viruses, cause great economic damage (Roy, 2000).

Diseases caused by fungi are biotic stress factors that cause yield loss in legumes. Fungal diseases cause a reduction in the yield of leguminous crops from 15% to 80% (Horoszkiewicz-Janka, 2013). The spread of some fungal pathogens becomes an epidemic process, which causes the closure of plantations (Deneke, 2018). Alternaria disease in leguminous crops is caused by the fungus *alternaria alternata*, and this disease is one of the most common diseases in leguminous crops (Mamta Sharma, 2013). Some species of the genus *Alternaria* are saprophytes, while other species are phytopathogens that cause several diseases in agricultural crops (Thomma, 2003).

Pathogenicity tests showed that *Cephalosporium sp.*, *F. solani*, *F. oxysporum*, *F. verticillioides*, *R. solani* and *N. dahliae* were the most pathogenic fungi isolated from beans. The amount of chlorophyll "a", chlorophyll "b", and carotenoids significantly decreased in plants infected with these pathogens, while total phenols increased in diseased plants (Elwakil et al., 2009). These results showed that there is a correlation between the amount of total phenols, as well as chlorophyll "a", chlorophyll "b" and carotenoids in the plant tissues of the above fungal diseases.

Alternaria alternata causes leaf spot and leaf blight diseases in several agricultural crops, including soybeans, causing significant losses (Nelson, 2001). *Alternaria leaf spot*, caused by the necrotrophic fungus *A. alternata*, is one of the most severe foliar diseases in soybean-growing regions of the world, and its pathogenicity is increasing even in the current changing climate.

Method

As a research object, the local soybean varieties Genetic-1, To'maris, Baraka, Nafis, Sochilmas, and micromycetes of the *Fusarium* and *Alternaria* species, which is kept in the the unique scientific object collection of phytopathogens and other microorganisms of the Institute of genetics and plant experimental biology of the Academy of Sciences of the Republic of Uzbekistan were used. Scientific research was carried out in 2021-2022 in lysimeters and laboratory conditions of the regional experimental station of the Institute of Genetics and Experimental Biology of Plants of the Academy of Sciences of the Republic of Uzbekistan, located in the Kibray district of the Tashkent region.

Field experiments were conducted in specially protected lysimeters. In the 1st background (control) of the experiment, clean (phytopathogen-free) seeds of soybean varieties were sown in the soil. In background 2 (experiment), soybean seeds were sown together with sterile oat grain infected with phytopathogenic micromycetes. The infection levels of soybean varieties with phytopathogenic micromycetes were determined by visual assessment of plants at growth and development stages.

Chlorophyll "a", chlorophyll "b", total chlorophyll, carotenoid content in plant leaves from physiological indicators during the budding period of plants under lysimeter conditions in the influence of phytopathogenic micromycetes on local and foreign varieties of soybean Nayek Sumanta, et. all.. (2014.) was determined by the following formula given in works.

$$Ch\text{-}a = 13.36A664 – 5.19\ A649$$
$$Ch\text{-}b = 27.43A649 – 8.12\ A664$$
$$C\ x{+}c = (1000A470 –2.13Ca- – 97.63Cb)/209$$

Results and Discussion

The amount of chloroplast pigments in the leaves of soybean cultivars artificially infested with phytopathogenic fungi during the budding phase was studied. When the amount of chlorophyll "a" was studied during the budding period of soybean, it was found that the amount of chlorophyll "a" in plants artificially infested with *F. oxysporum* and *A. alternata* was reduced in different degrees compared to the control plants. Among the soybean varieties infected with *F. oxysporum*, Baraka, Tomaris and Genetik-1 varieties had a high amount of chlorophyll "a" (3.19±0.11 mg/g, 3.28±0.41 mg/g and 3,01±0.24 mg/g), while Nafis and Sochilmas varieties had low values (1.66±0.34 mg/g and 1.61±0.27 mg/g, respectively) (Table 1) .

Table 1. Amount of pigments during budding period of local soybean cultivars.

Varieties	chlorophyll "a"			chlorophyll "b"		
	Control	*F.oxysporum*	*A.alternata*	Control	*F.oxysporum*	*A.alternata*
Genetic-1	3,83±0,26	3,01±0,24	3,08±0,11	1,74±0,06	1,32±0,32	1,09±0,61
Baraka	3,28±0,23	3,19±0,11	2,95±1,00	1,96±0,40	1,00±0,57	1,14±0,16
Tumaris	4,01±0,18	3,28±0,41	3,04±0,41	1,77±0,27	1,18±0,25	1,29±0,27
Nafis	3,15±0,09	1,66±0,34	1,88±0,18	1,93±0,09	1,10±0,14	0,83±0,23
Sochilmas	2,75±0,28	1,61±0,27	1,90±0,39	1,17±0,18	0,69±0,23	0,75±0,28

Among the soybean varieties infected with *A. alternata*, Genetik-1 and To'maris varieties had high chlorophyll "a" quantity (3.08±0.11mg/g and 3.04±0.41mg/g, respectively), while Sochilmas variety had a low quantity (1.90±0.39 mg/g). When the amount of chlorophyll "b" in the leaves of soybean cultivars was studied during the budding period, it was found that the amount of chlorophyll "b" in the plants artificially infested with *F. oxysporum* and *A. alternata* was reduced in different degrees compared to the control. Among the soybean varieties infested with *F. oxysporum*, the amount of chlorophyll "b" was high in To'maris and Genetic-1 varieties (1.18±0.25 mg/g and 1.32±0.32 mg/g, respectively), in Sochilmas variety had a low index (0.69±0.23mg/g).

Among the soybean varieties infested with *A. alternata*, To'maris variety had a high chlorophyll "b" quantity (1.29±0.27mg/g), while Sochilmas variety had a low quantity (0.75±0.28mg/g). The amount of carotenoids in the leaves of soybean cultivars was also studied. As a result of the action of phytopathogenic fungi, it was found that the amount of carotenoids in the leaves increased in different degrees compared to the control. Among soybean varieties which were artificially infected with *F. oxysporum*, the highest carotenoid content index was found in To'maris variety (1.50±0.18 mg/g), and the lowest indicator was found in Sochilmas variety (0.99±0.09 mg/g) (2 -table).

Table 2. Carotenoid content index results

№	Varieties	Total chlorophyll			Carotenoid		
		Control	*F.oxysporum*	*A.alternata*	Control	*F.oxysporum*	*A.alternata*
1	Genetic-1	5,57±0,10	4,34±0,40	4,17±0,66	1,32±0,10	1,30±0,25	1,62±0,34
2	Baraka	5,24±1,28	4,19±0,74	4,09±0,12	0,91±0,70	1,39±0,16	1,04±0,14
3	Tumaris	5,78±0,33	4,46±0,48	4,33±0,49	0,64±0,25	1,50±0,18	1,48±0,25
4	Nafis	5,08±0,15	2,76±0,41	2,71±0,33	0,90±0,23	1,11±0,18	1,19±0,16
5	Sochilmas	3,92±0,45	2,30±0,30	2,65±0,33	0,71±0,27	0,99±0,09	1,09±0,04

Amount of pigments during budding period of local soybean cultivars.Among soybean varieties which were artificially infested with A. alternata, the highest index of carotenoid content was determined in Genetic-1 variety (1.62±0.34mg/g), and the lowest index in Baraka variety (1.04±0.14mg/g). In conclusion, when the amount of chloroplast pigments of local soybean varieties artificially infested with phytopathogenic fungi was studied, it was found that To'maris, Genetik-1 and Nafis varieties were more resistant to F. oxysporum and A. alternata than other varieties.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in EPHELS journal belongs to the authors

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Author(s) Information

Hilola Matniyazova
Academy of Sciences of Uzbekistan,
Tashkent, Uzbekistan
Contact e-mail: *hilolamatniyazova@gmail.com*

Utkir Yuldashev
Academy of Sciences of Uzbekistan,
Tashkent, Uzbekistan

Dano Karshibayeva
Department of Biology, Chirchik State Pedagogical Institute,
Tashkent, Uzbekistan

Marifat Salohiddinova
Academy of Sciences of Uzbekistan,
Tashkent, Uzbekistan

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