Toxic residue amount of pesticides used to control diseases in strawberry agrobiocenosis

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Abstract. This article presents the results of the studies on the effects of fungicides on strawberry fruits used against the diseases, and according to the results of the conducted scientific study, 0.01 mg/ml residue amount of fungicide was detected when the application of preparations containing *Difenoconazole* active substance to control diseases occurring in strawberry agrobiocenosis, grown in open field and greenhouse conditions, was stopped 15 days before fruit ripening, also it was observed that when application of fungicides was stopped 30 days before fruit ripening, no toxic residue was found. When similar experiments were carried out under greenhouse conditions, after 15 days of fungicide application the toxic residue amount was 0.02 mg/ml, but after 30 days no toxic residue amount was detected. When similar experiments were carried out under greenhouse conditions, after 15 days of fungicide application the toxic residue amount was 0.02 mg/ml, but after 30 days no toxic residue amount was detected.

1 Introduction

The increase in the world's population and its requirements for food require the search for additional resources to increase the production of agricultural products, the efficient use of agricultural land, and the production and introduction of new innovative technologies. So, to meet the demand for food, strawberry production is being increased, as the world production of strawberry is 9.5 million tons [1-6]. The main 47.9% of the cultivated crop falls on the Asian continent and 24.5% on the American continent. China is the world leader in the production of strawberry (Fragariaspp) and harvests 3.35 million tons. The USA cultivates 1.26 million tons of strawberry, Turkey 728 thousand tons and Egypt 638 thousand tons of strawberry (FAO stat, 2022).

Along with fruits and vegetables, berries also have a special role in the completeness of food rations. In the conditions of our republic, among these crops, strawberry is one of the types of berries that are continuously grown. It is grown mostly by the residents of

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Tashkent region among other regions of the country in open fields and also in greenhouse conditions.

Strawberry Fragaria x ananassa (Duchesne ex Weston) Duchesne ex Rozier (garden strawberry) is a perennial herbaceous plant belonging to the Rosaceae family, and this type of crop is cultivated in more than 75 countries of the world. Strawberries make up more than two-thirds of the berry crop grown in the world [7].

Pesticides are used to control harmful organisms to prevent severe crop losses, which have devastating nutritional and economic consequences. Fungicides and bactericides accounted for 43% of total pesticide sales in the European Union (EU) in 2020. Triazole fungicides are the most common type, and their market is expected to reach $4.90 billion by 2028 [8-10].

Difenoconazole, a broad-spectrum systemic triazole fungicide, is one of the most widely used fungicides due to its high efficacy against some fungal diseases.

The production of Orgamika F biopreparation from biological preparations against diseases has given good results.

Difenoconazole - [cis, trans-3-chloro-4-methyl-2-(1N-1,2,4-triazol-1-methyl)-1,3-dioxolane-2-phenyl-4-chlorophenylether] is considered an active substance of pesticides [6]. Difenoconazole is a white crystalline substance. It is soluble in most organic solvents and is stable up to 300°C. Consists of a mixture of cis and trans isomers.

Preparations based on difenoconazole have low toxicity for warm-blooded creatures. They are considered safe for humans and animals. For example, the lethal dose (LD50) of difenoconazole for rats is 1453 mg/kg, indicating its low toxicity [3, 5].

Difenoconazole is an almost immobile substance in soil. This means it has a high sorption capacity, meaning it binds strongly to soil particles and is not absorbed into deep soil layers or water sources. As a result, the movement of difenoconazole in soil is limited and the risk of getting into groundwater is low. This feature contributes to the local effect of the preparation and its rapid decomposition in the soil. Because of this, its residual amount is almost gone or reduced to non-existent within a few days, especially during the first few years of its application. In addition, the fact that the preparation does not remain in the soil for a long time and does not fall into deep layers reduces its ecological risk [9].

Information is provided on the damage and development of white spot disease in strawberry crops in strawberry cultivation in greenhouse conditions of Tashkent region and the cause of this disease by the fungus Ramularia tulasnei. The prevalence of the disease was 34.7% and the development was 22.1%.

In the studies related to the preparation "Skor" based on difenoconazole, its residues were not found three days after the preparation was applied to the soil. But after three years in the analogue protection system, residual amounts of the preparation (not exceeding MPC (maximum permissable concentration) standards) were observed in the soil for 14 days. Additional studies show that over time, the period of complete decomposition of the preparation increases to 21 - 24 days, which is observed after the last, fourth treatment. In studies carried out for six years, very small amounts of preparation residues remained in the soil in the form of "traces" during the entire vegetation period, that is, until harvest. These data clearly demonstrate the dynamics of difenoconazole in soil and how its residue levels change over time and allow us to conclude on the stability of this substance in soil. [8].

Strawberry fruit contains 4.5-10.0% of sugar, 0.9-1.7% of organic acids, 0.9-1.7% of nitrogenous substances, and 0.6% of pectin that are very necessary for human health. Strawberry fruit is rich in vitamin C (50-120 mg/100 g), in addition, it contains vitamin E (0.78 mg/100 g), carotene (0.08 mg/100 g), 13.9 (0.5-0, 6 mg/100 g), vitamin PP (1.0-1.4 mg/100 g), anthocyanins (0.05-0.9%) and coloring substances (34-125 mg/100 g). Effects of fungicides used against plant diseases.

2 Materials and Methods

The laboratory experiments within the framework of the project were carried out in 2024 in the "Plant Protection and Quarantine" laboratory of the scientific research institute of horticulture, viticulture and winemaking named after Academician M. Mirzayev.

Strawberries were picked and brought from the options that were treated with the preparation based on active substance *difenoconazole*. First, the fruits were measured by 1 kg on an analytical scale. Then the fruits were brought to a liquid state using a juicer. Then the mass of liquid from each sample was measured, placed in a special Eppendorf container and dissolved in 1.5 ml of acetonitrile (polar) solvent. The solution was placed in a centrifuge for 10 minutes to make it a more complete solution. Then the solution was removed from the centrifuge and the solution part was separated from the sediment part. This solution was diluted to a concentration of 0.01 mg/ml. Each standard and experimental sample was prepared in the same manner.

Preparation and identification of samples was carried out using S.N. Bikovsky methodology. Prepared standard and experimental samples were analyzed by FlexarHPLC (liquid chromatography).

3 Results and Discussion

The amount of toxic residues from chemical preparations in cultivated products used against harmful organisms found in agricultural crops has a direct and serious impact on the health of consumers. Therefore, it is necessary to determine their different standards and norms in the composition of agricultural products.

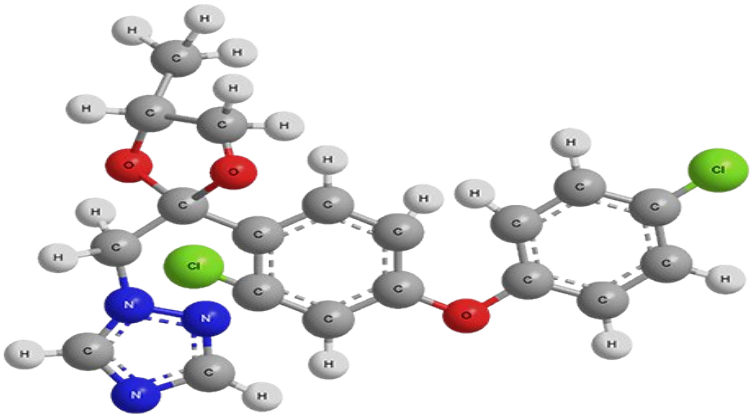

Fig. 1. Chemical appearance of *difenoconazole*.

Toxic residue is the amount of harmful chemicals (pesticides, herbicides, insecticides, and other chemicals) left in food, water, or the environment that pose a risk to human health. These residues can enter the human body through food and water.

In the control of the diseases occurring in strawberry agrobiocenosis grown in the open field and in greenhouses, the preparations with the active substance *Difenoconazole* were used (figures 2-6). Table 1 shows the presence of the residue amount of the preparations containing *difenoconazole* as an active substance in the tested samples.

Table 1. Determining the amount of toxic residue of preparations with the active substance *Difenoconazole* in the cultivated crop used against diseases occurring in strawberry agrobiocenosis.

№	Crop area	Determination of toxic residual amount of pesticides in 1 kg of fruit, by days	
		15 days	30 days
1.	Open field	0,01	0,0
2.	Greenhouse	0,02	0,0

When similar experiments were carried out under greenhouse conditions, after 15 days of fungicide application the toxic residue amount was 0.02 mg/ml, but after 30 days no toxic residue amount was detected.

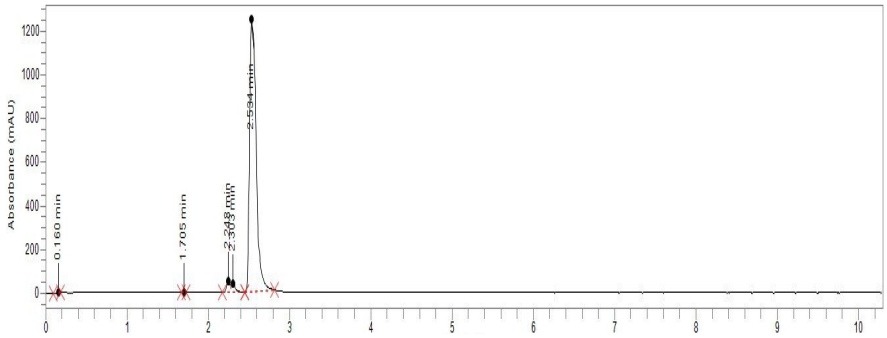

Fig. 2. *Difenoconazole* standard.

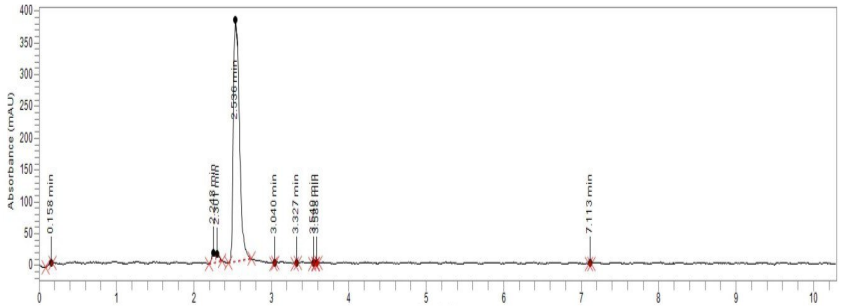

Fig. 3. The amount of residue in the fruit from preparations containing difenoconazole as an active ingredient used against diseases occurring in strawberries grown in the open field (15 days of application).

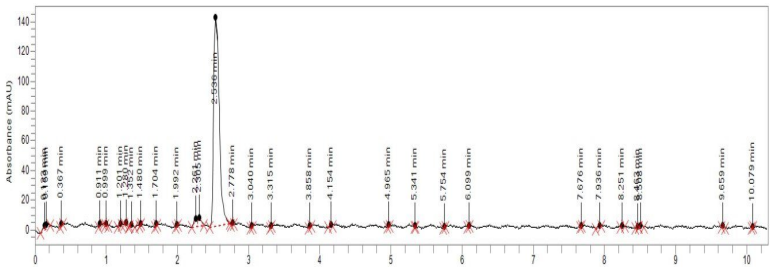

Fig. 4. The amount of residue in the fruit from preparations containing difenoconazole as an active ingredient used against diseases occurring in strawberries grown in the greenhouse (15 days of application).

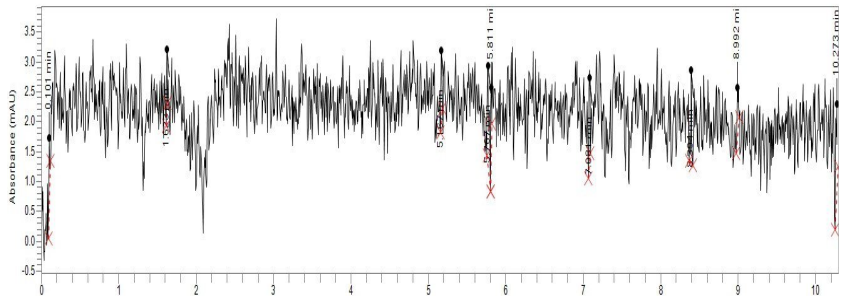

Fig. 5. The amount of residue in the fruit from preparations containing difenoconazole as an active ingredient used against diseases occurring in strawberries grown in the open field (30 days of application).

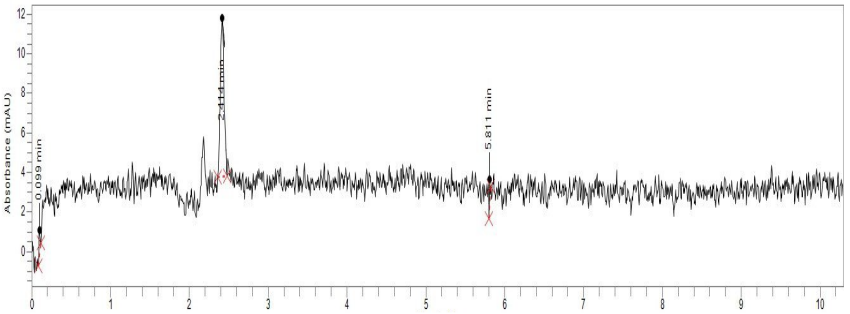

Fig. 6. The amount of residue in the fruit from preparations containing difenoconazole as an active ingredient used against diseases occurring in strawberries grown in the greenhouse (30 days of application).

4 Conclusion

According to the results of the conducted scientific study, 0.01 mg/ml residue amount of the preparation was detected when the application of preparation containing *Difenoconazole* active substance to control diseases occurring in strawberry agrobiocenosis, grown in open field and greenhouse conditions, was stopped 15 days before fruit ripening, also it was observed that when application of fungicides was stopped 30 days before fruit ripening, no toxic residue was found.

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