ORGANIC TREATMENTS FOR THE CONTROL OF *MYCOSPHAERELLA FRAGARIAE* INFECTION IN THE ECOLOGICAL CROP SYSTEM OF *FRAGARIA VESCA*

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Abstract. The damage caused by *Mycosphaerella fragariae* infection is one of the main foliar diseases of wild strawberries. The leaf spot disease decreases significantly the photosynthetic area and the quality of the fruits. This fungal disease caused by *Mycosphaerella fragaria* is an important factor that is limiting the crop production and it causes high costs due to yield losses and expensive pesticide applications. Traditionally, the main procedure for disease control in wild strawberry production depends on chemical treatments and pre-plant fumigation. Recently, alternative methods of disease control have been sought and researched, because of the increasing request for organic food. This study evaluates the effect of two organic treatments for the leaf spot disease on wild strawberry irrigated crop.

Keywords: *Mycosphaerella fragariae, Fragaria Vesca L.*, agro-homeopathy, organic treatments.

INTRODUCTION

Fragaria vesca var. semperflorens 'Alexandria' commonly called **wild strawberry** is one of the plants from the ***Rosaceae*** family and is known for its dainty, dark red berries that are fragrant, delectable and rich in antioxidant content. The wild strawberry culture needs naturally moist and well drained sandy-clay soil which is rich in organic matter. In the organic system a critical point is the adaptation of the plant to the particular condition of the region(1).

One of the common diseases of *Fragaria vesca* is the leaf spot, caused by *Mycosphaerella fragariae*. The symptoms of the disease are the small purplish circular spots on the surface of young leaflets. In the next stage the lesion will be enlarged and the center of the spot will turn grayish to white on older leaves and it will be surrounded by distinct reddish-brown borders. The leaf spot fungus can also contaminate leaf stems, stalks, petioles, runners, peduncles of the flowers and calyces of the fruit. The attracted areas will exhibit infected spots similar to those described for leaves. On the area of stems and stalks, the lesions are rather elongated than circular. The infection of strawberry fruit is not common. The contaminated berries have several seeds surrounded by brown-black areas. Usually there are one or two spots per fruit. The presences of these lesions lower the quality of the fruit and make the fruit unmarketable.

The leaf spot disease is favored by extended wet and cold periods in winter and spring. In the winter period the fungus survives as spore from the lesions of the leaves. The contamination starts in early summer when the fungus infects the plant and

produces a large amount of spores in the spots on the surface of leafs. Rain is the main factor that will spread the spores. The most affected leafs are the middle-aged leafs. The most favorable temperatures for germination and production of fungus conidia are between 13^0C-21^0C(1)(2)(3)**.** The incidence of leaf spot disease in the irrigated crops is higher and in these cultivars the fungus may also contaminate the fruits (1).

It is known the importance of silicon in protecting crops from for the environmental stresses such as resistance to water stress, disease and pest attack. Even if silicon isn't an essential element in the physiology of the plants, it is considered an important and beneficial micronutrient for the development of the plants. The fertilization that involves silicon has an effect on the structural rigidity of tissues that increases the protection against fungus, insect attack and it also influences the accumulation of phenolic compounds by forming a natural barrier(1)(4). *Equisetum sp.* has as main chemical compounds: silicon (10-15%), gallic acid, potassium salts, luteolin, isoquercitin, thiamines, saponins, triglycerides, alkaloids, inorganic compounds, tannins and vitamin C.

Agro-homeopathy is one of the recently developed approaches in agricultural research. Over the past few years there has been an increase in the number of scientific studies that show the effect of homeopathic drugs that control pathogen and diseases of the plants. The homeopathic drugs can be used safely in diverse cases like: seed germination, health of the soil, flowering, fruiting and protection against the biotic and abiotic stress of the plants. The appropriate selection of homeopathic medicine can be very efficient to increase crop yields and the quality of the plants that are cultivated.

It is essential to develop a Homeopathic Materia Medica for the regnum Plantae, because it is necessary to have an individualized treatment for different types of diseases and disorders of the plants. The homeopathic drugs are prepared using a procedure of successive dilution and "dynamization". And the homeopathic medicine uses two power scales the decimal scale (1:10) and the centesimal scale (1:100) (5). This work aims to discover practical and efficient alternatives for the ecological cultivation of wild strawberry.

MATERIAL AND METHODS

The design of the experiment was made with randomized blocks with three treatments and six repetitions.

The treatments were as follows:

1) T1-Water - 2000ml were administrated in the morning and in the evening;

2) T2 -*Equisetum arvense* (hydro-alcoholic extract) - 5ml in 100ml water and then dissolved in 2000ml water which was used to treat the wild strawberries plants.
The *Equisetum arvense* solution is an extract 1: 3.75 in hydroalcoholic solution (ethyl alcohol / water - 35/65 by mass) from aerial parts of horsetail plant. The Hydro-alcoholic extract was administrated in the morning and in the evening.

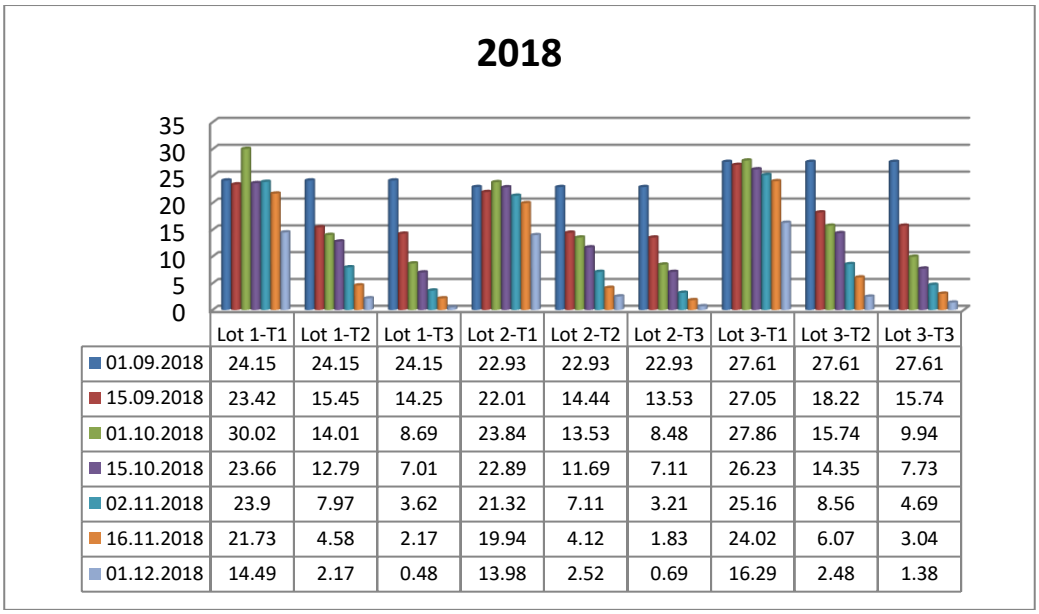
3) T3-Homeopathic formulas – a) *Equisetum hyemale* D6 + *Equisetum arvense* D6 + *Psoriunum* CH7 and b) *Equisetum hyemale* CH30 + *Equisetum arvense* CH30 + *Psoriunum* CH30. Three granules from each type of homeopathic drug of the formula was dissolved in 100ml water and then dissolved in 2000ml water which was used to treat the wild strawberries plants. The mix ''a" was administrated in the morning and

the mix "b" was administrated in the evening.The homeopathic drugs were purchase from the manufacturers Plantextract and Boiron.

The method for the treatment application was sprinkling. The attack started at 1st of September, thus the applications of the treatments were made daily in the first week. Afterwards, the treatement was applied weekly until 1st of December .The method used for the evaluation of the impact of the leaf spot infection was the quantification of plant diseases called Fitopatometria(1). The observed intensity of the disease it's described by the broad terms that can be expressed as incidence or severity (how intense it is the disease or how sick the plant is). The form of evaluation is the direct measurement of symptoms of the disease, by counting the number of injuries(1).

RESULTS AND DISCUSSIONS

The experiments were carried out in 2018 and 2019 in the area of the Vladeasa Mountains. In 2018 the damage produced by *Mycosphaerella fragariae* decreased from 75%, with an average of 24,90 spots per leaf, in the control area treated with water (T1) to less than 5% in treatment with *Equisetum arvense* hydro-alcoholic extract (T2) and less than 3% in the treatment with the 2 homeopathic formulas (T3). Both treatments had an important influence on the control of the disease caused by *Mycosphaerella fragariae*.

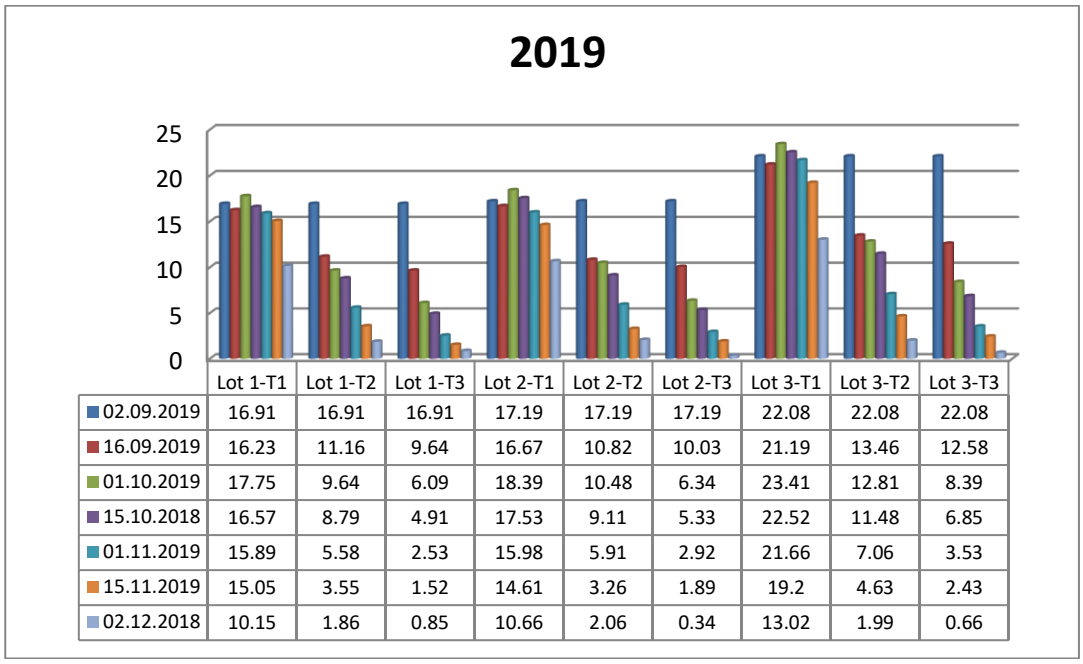


	Lot 1-T1	Lot 1-T2	Lot 1-T3	Lot 2-T1	Lot 2-T2	Lot 2-T3	Lot 3-T1	Lot 3-T2	Lot 3-T3
01.09.2018	24.15	24.15	24.15	22.93	22.93	22.93	27.61	27.61	27.61
15.09.2018	23.42	15.45	14.25	22.01	14.44	13.53	27.05	18.22	15.74
01.10.2018	30.02	14.01	8.69	23.84	13.53	8.48	27.86	15.74	9.94
15.10.2018	23.66	12.79	7.01	22.89	11.69	7.11	26.23	14.35	7.73
02.11.2018	23.9	7.97	3.62	21.32	7.11	3.21	25.16	8.56	4.69
16.11.2018	21.73	4.58	2.17	19.94	4.12	1.83	24.02	6.07	3.04
01.12.2018	14.49	2.17	0.48	13.98	2.52	0.69	16.29	2.48	1.38

Fig. 1. The evaluation of organic treatments on the *Fragaria vesca* leaves infected with fungus *Mycosphaerella fragariae* in the 2018 crop.

In 2019 the damage produced by *Mycosphaerella fragariae* decreased from 75% infested area (2018) to 50% affected area of the crop. And the spot average decreased from 24,90 spots per leaf to an average of 18,72 spots per leaf (a 25% decreaes).

The damage produce by *Mycosphaerella fragariae* in the ecological crop of *Fragaria vesca* decreased from 50%, with an average of 18,72 spots per leaf, in the control area treated with water (T1) to less than 5% in treatment with *Equisetum arvense* hydro-alcoholic extract (T2) and less than 3% in the treatment with the 2 homeopathic formulas (T3). The treatments with *Equisetum arvense* hydro-alcoholic extract (T2) and with the 2 homeopathic formulas (T3) had a significant influence on the treatment of the disease caused by *Mycosphaerella fragariae* as it can be observed in the Figure 2.



	Lot 1-T1	Lot 1-T2	Lot 1-T3	Lot 2-T1	Lot 2-T2	Lot 2-T3	Lot 3-T1	Lot 3-T2	Lot 3-T3
02.09.2019	16.91	16.91	16.91	17.19	17.19	17.19	22.08	22.08	22.08
16.09.2019	16.23	11.16	9.64	16.67	10.82	10.03	21.19	13.46	12.58
01.10.2019	17.75	9.64	6.09	18.39	10.48	6.34	23.41	12.81	8.39
15.10.2018	16.57	8.79	4.91	17.53	9.11	5.33	22.52	11.48	6.85
01.11.2019	15.89	5.58	2.53	15.98	5.91	2.92	21.66	7.06	3.53
15.11.2019	15.05	3.55	1.52	14.61	3.26	1.89	19.2	4.63	2.43
02.12.2018	10.15	1.86	0.85	10.66	2.06	0.34	13.02	1.99	0.66

Fig. 2. The evaluation of organic treatments on the *Fragaria vesca* leaves infected with fungus *Mycosphaerella fragariae* in the 2019 crop.

CONCLUSIONS

It is obvious that the two treatments applied on the *Fragaria vesca* plots affected by the leaf spot disease were effective in treating the damaged area. In the second year the treatments applied in 2018 decreased significantly the incidence of the disease caused by *Mycosphaerella fragariae*.

The organic treatments could be the solution for plant cultivation without changing the quality of plants and soil. However, it is necessary to conduct more experiments in field conditions as well as pilot studies on organic properties of the natural treatments.

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