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Alternative Treatments For Powdery Mildew, Spot Blotch And Fusarium Wilt On Autumn Cereals With Essential Oils From Menthe Pulegium, Eugenia Aromatica And Cedrus Atlantica.

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Abstract: *The fungicidal effect of essential oils (EOs) extracted from three aromatic and medicinal plants: Mentha pulegium, Eugenia aromatica and Cedrus atlantica was tested on three fungal diseases of autumn cereals: powdery mildew, spot blotch and wheat crown rot, caused by Erysiphe graminis, Bipolaris sorokiniana and Fusarium culmorum respectively. Two concentrations of 1.25 ml / L and 0.156 ml / L of the three EOs were tested in a greenhouse on barley, soft wheat and durum wheat varieties with a preventive method by soaking seeds before sowing or a foliar spraying at tillering stage. The best results were obtained by a concentration of 1.25 ml / L of the three EOs that completely controlled powdery mildew disease on durum wheat plants from seed soaking, and barley Acssad 68 plants when foliar sprayed. However, Rabat 071 seed-soaked barley, we found a decrease of powdery mildew disease severity of 34% with Mentha pulegium EO, 22% with Cedrus Atlantica EO and 14% with Eugenia aromatica EO. For spot blotch disease, foliar spray treatment with a concentration of 1.25 ml / L of Cedrus atlantica EO reduced disease severely by 53% for durum varieties (Waha and Tomouh). For barley varieties, (Adrare and Ferdaous) disease reduction was by 50% and 50% for the Tilila variety of soft wheat. Mentha pulegium EO reduced the leaf spot disease by 50% on the same varieties of barley, 50% on the same variety of soft wheat and 47% on the same varieties of durum wheat. With Eugenia aromatica EO, spot blotch disease was reduced by 33% on the soft wheat variety, 20% on the durum varieties and 8% on the barley varieties. While for wheat crown rot control, seed soaking was the best technique with 0.156 ml /L concentration. The decrease was reduced by 33% with Eugenia aromatica EO on the Amalou barley variety; Mentha pulegium EO reduced it by 23% on Chaoui durum variety and 21% on Tissa barley variety.*

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I. Introduction

Grain farming has a major role in the agricultural economy of Mediterranean region countries by both the role of wheat and barley in the diet of the citizens and as they allow trade during years when harvest is in surplus.[1].

In Morocco, cereal represent over 75% of the utilized agricultural area (UAA)[2] ;and durum wheat, bread wheat and barley account for 33%, 35% and 32% respectively of total cereals[3]. This dominance of the UAA by cereals makes agriculture seedsvery weak, less diversified, and therefore more vulnerable to climatic change with all its negative consequences onproduction variability and sector growth. This climatic change may induce and stimulate losses caused by biotic stresses, characterized by diseases, insects and pests in addition to abiotic stresses like heat and water stress.

Cereal fungal diseases of can be classified into three groups: soil-borne diseases caused by fungi living in the soil (damping-off, root rot), diseases transmitted by seeds including bunts, spike and leaf diseases which are obviously the most important because they destroy the tissues of leaves which they reduce the photosynthetic efficiency. All these diseases are explosive and can spread very quickly in susceptible varieties when climatic conditions are favourable to them[4].

Powdery mildew of grasses has been known for centuries, it is one of the first recognized plants diseases ; caused by the fungus *Erysiphe graminis* an obligate parasite, the disease is widely distributed but more damaging in cool, wet climates and semi-arid areas[5]. The first sign of attack by this parasite is the appearance of spots in

the form of whitish or light grey duvets on basal leaves.During the progression of the disease, duvets develop to upper the leaves. When climate conditions are conducive spots of powdery mildew, appear on seeds,

leaves and glumes[6]. In Morocco, this disease is a major constraint on barley: the causative agent attack all aerial parts of the plant[7].

Spot blotchis found wherever barley, wheat and many other grasses are grown. However, it causes significant losses only in areas where there is a hot and humid climate.This disease is caused by *Cochliobolus sativus* which is the imperfect state of the fungus *Bipolaris sorokiniana* also called *Helminthosporium sativum*. Spots develop on leaves and leaf sheaths at all stages of plant development.Lesions are uniformly brown, often with yellow halos of round to oblong shapes, of varying size.Pigments can continue to expand and combine to cover large areas of the leaf.The earliest lesions are of olive colour due to the fungus sporulation.Severely infected leaves senesce completely[5].

Fusarium wheat crown rot, foot rot, dry root rot, is caused by *Fusarium culmorum*.Hard wheats are most susceptible followed by soft wheats, barleys, and triticale.Major symptoms, are found at plant stem base and are of a brown colour at the beginning and end up being pink at the end of the cycle, often extending over 2 to 4 lower nodes of the stems[8]. In the field, the most noticeable symptoms of root rot are the symptom of whitehead.When the seeds are heavily infected, there are always pre- or post-emergence problems leading to early death of seedlings[7].

In recent decades, various attempts have been proposed to prevent, control or eradicate plant diseases but each has advantages and disadvantages, and use of certified seeds and treated with appropriate fungicides allowed sufficient production and at a lower cost to satisfy both market and consumer need[9, 10, 11]. Although effective, their continued or repeated applications can disrupt the balance of ecosystems leading to disease outbreaks and cause widespread development of resistant pathogens.Furthermore, various types of fungicides are also toxic to non-target organisms, and environmental problems[12, 13]. Resistant varieties can be overcome by emergence of new virulent strains.

Use of chemical fungicides, has led scientists to look for new antimicrobial substances such as plant extracts that are safer than synthetic products because they are biodegradable in nature and non-polluting[14]. Plants produce over a hundred thousand natural secondary metabolites of low molecular weight whose amount and type depend on environmental conditions and geographical situation[15].Many studies look ecological role of these compounds, and activity of compounds from herbal species were used to control insects and plants diseases fungi[16, 17, 18]. In most cases, the antifungal activity of the plant extracts was evaluated*in vitro*[19, 20, 21].

In contrast, his work consisted of testing*in vivo*the effect of essential oils of*Mentha pulegium, Eugenia aromatica* and *Cedrus atlantica* to control cereal diseases wheat crown rot, spot blotch and powdery mildew.

II. Material and methods

Used essential oils were extracted by Clevenger methodfrom cloves, *Mentha pulegium* leaves and the of *Cedrus atlantica*bark in the laboratory of Applied Chemistry and Environment of the Faculty of Sciences and Technology of Settat in November 2015.

Cereals seeds used for this study were taken from the stock of phytopathology laboratory of INRA Settat.

About the causative fungi of the studied diseases, *Bipolaris sorokiniana* and *Fusarium culmorum*have been identified,andthen isolated from commercial barley seeds at the plant pathology laboratory of INRA Settat:these two fungi were multiplied and regularly renewed their culture by subculture on PDA (Potato-Dextrose-Agar) culture medium for *Fusarium culmorum* and on the V8 culture medium for *Bipolaris sorokiniana*.*Erysiphe graminis* was naturally airborne and the disease developedeasily with greenhouse moisture[22].

Diseases control experiments were carried out under greenhouse in pots or trays containing natural soil adequately amended with DAP (Diammonium Phosphate).Plants were irrigated with natural water and fertilized with nitrogen fertilizer as needed.

Procedure methodology

Effect of seed imbibition in EO solutions on seed germination

For the first experiment, seeds of barley varieties: Oussama and Rabat071 and durum wheat Ourgh were soaked in solutions of 1.25 ml/L of the mixture EO-water for the three EOs. Seeds soaked in water were used as controls; after 24 hours, 20 seeds of each variety were placed in a Petri dish containing 2 rolls of Wattman paper, two replicates plates were made for each variety then seeds were irrigated with natural water according to their needs.

After we noticed that some seeds did not germinate, we made other tests with different concentrations and different cereal varieties.

For the second experiment, seeds of barley varieties Acssad 68 and Rabat071 and durum wheat Ourgh were soaked, for 24 hours, in the solution of concentrations 0.625 ml/L, 0.312 ml/L and 0.156 ml/L of the 3

E0sand seeds soaked in water were used as a control treatment. For each variety, 50 seeds were placed in a Petri dish containing 2 rolls of Wattman papers. For each treatment, each concentration had two replicates per variety. In a third experiment, seeds of 10 varieties of barley, 9 varieties of durum wheat and eight varieties of soft wheat were soaked, during 24 hours, in solutions of 0.156 ml/L concentration of *Mentha pulegium* and *Eugenia aromatica*.The seeds soaked in water were used as controls; 50 seeds of each variety were placed in a Petri dish containing two superposed Wattman papers; each variety had two repetitions.

The rate of germination reduction, due to essential oils, was calculatedas following (1):

$$GRR(\%) = \frac{RUC - RTC}{RUC} * 100. \qquad (1)$$

Where GRR (%) is the germination reduction rate of a variety, RUC represents germination rate for untreated controls seeds of the variety and RTC is germination rate for treated seeds of the same variety.

Wheat crown rot

Preparation of inoculums: to get liquid inoculumof *Fusarium culmorum*, petri dishes with purified fungi were scraped and rinsed with distilled water; the mixture was filtered through a very fine mesh fabric toseparate fungi conidia from any pieces of culture media[23].

*Fusarium culmorum*powder was prepared as follows: 50 grams of barley were soaked in an Erlenmeyer flask containing 50 ml of water. After sterilization and cooling, the mixture was inoculated with *Fusarium culmorum*, purified and then incubated at 20 °C for 3months after which the content of the flask was dried in open air and then grounded to have a fine powder.

Induction of disease resistance: it was madeby soaking seeds in solutions ofdifferent concentrations of a mixture EO-1L waterfor 24 hours before sowing.

Disease inoculation:*Fusarium culmorum*was inoculatedto crown roots[24].During first experiment and for each of the three EOs, four pots were sown with 15 Ourgh durum wheat seeds that were previously soaked in each essential oil's 1.25ml/L concentration solution and water as control. Each pot was inoculated with 0.4 grams of *Fusarium culmorum* powder then covered with a 1 cm layer of natural soil, the experiment had four repetitions. Disease evaluationwas performed when plant reached heading stage.

Asecond experiment was carried out on seeds thathad been dipped in the 0.156 ml/L EO solution concentrations of *Mentha pulegium*, *Eugenia aromatica* and water as a control and then germinated on the Petri dishes. Those were seeds of two varieties of barley (Amalou and Tissa), two varieties of durum wheat (Annouar and Chaoui) and two varieties of soft wheat (Arrihane and El Kheir). At 1-leaf development stage, each Petri dish received 1ml of *Fusarium culmorum* liquid inoculum, 24 hours later, the plants were transplanted into trays (1 tray per species) 10 plants were used per hole; for each variety one line consisting of 4 holes were transplanted by cultures that had received the same treatment, the test had two repetitions.

Wheat crown rot disease evaluation:it was made according to two criteria:

1. disease severity on a scale from 0 to 3, these figures for the number of attacked nodes for each plant;
2. the weight of dry biomass for plants which received the same treatment

Spot blotch

Preparation of inoculums: liquid inoculum *Bipolaris sorokiniana*was prepared by scraping and rinsing petri dishes with purified fungi with distilled water. The mixture obtained was filtered through a very fine mesh fabric to separate fungi conidia from any pieces of culture media.[23].

Induction of disease resistance: was madeby two methods:

1) by soaking seeds in solutions of different concentrations of a mixture EO-1L water for 24 hours before sowing,
2) by foliar spraying of different concentrations of EO-water mixtures, 24 hours before disease inoculation [25]

Disease inoculation: *Bipolaris sorokiniana* was inoculated by foliar sprays[26].

One experiment was carried out with seeds of a barley variety Oussama, soaked for 24 hours in the solutions of concentration 1.25 ml/L of the three essential oils and water as a control. After draining the seeds, for each treatment, four pots were sown with 15 seeds each;the test was repeated 4 times.At the 4-leaf growth stage, Oussama barley plantswere inoculated with a 150 ml solution of *Bipolaris Sorokiniana* conidia containing 10^3 CFU/ml, homogenized and suspended using Tween-20.To keep moisture, inoculated plants were covered with polyethylene film[27] for 5 days.The first assessment of disease was made 10 days after inoculation, a second assessment was conducted one week later.

A second experiment was conducted with seeds previously soaked in solutions of concentration 0.156 ml/L of the EOs of *Mentha pulegium* and *Eugenia aromatica* and left to sprout in Petri dishes. These were two varieties of barley (Adrare and Ferdaous), two varieties of durum wheat (Waha and Tomouh) and one variety of common wheat (Tilila): at one leaf growth-stage, plants were transplanted in trays, 7 plants of each variety per hole. For each variety, every treatment had three repetitions. At the 3-leaf stage, the cultures were inoculated with *Bipolaris sorokiniana*and then covered for 5 days with polyethylene.Spot blotch evaluation was made 10 days after inoculation.

A third test was carried out in trays using seeds of Oussama barley variety immersed in solutions of 0.156 ml / L concentrations of*Mentha pulegium* and *Eugenia aromatica* EOs.Seeds soaked in water and dry seeds were used as controls: for each treatment,three rows consisting of four holes each were used; each hole was sown with five seeds, the experiment was repeated twice.At 3-leaf growth stage, plants were inoculated with *Bipolaris sorokiniana* and then covered with plastic polyethylene for 5 days; assessment of spot blotch disease was made 10 days after inoculation.A fourth test was done in trays with plants of two varieties of barley (Adrare and Ferdaous), two varieties of durum wheat (Waha and Tomouh) and two varieties of common wheat (Tilila and Arrihane). Plants were treated by foliar spraying with solutions of 1.25 ml/L concentration of each EO-water mixture; untreated plants were kept as controls. 24 hours after spraying EOs, all plants were inoculated by foliar spray with 250 ml of a solution of 10^3CFU/ml *Bipolaris sorokiniana* conidia homogenized and suspended with Tween-20, and they were covered for 5 days.The evaluation of the disease was made 10 days after inoculation.

Spot blotch disease evaluation: was carried out by percentage of the diseased leaf area[22].

Powdery mildew

Induction of disease resistance: was made by two methods:

1. by soaking seeds in solutions of different concentrations of a mixture EO-1L water for 24 hours before sowing,
2. by foliar spraying of different concentrations of EO-water mixtures, 24 hours before disease inoculation [25].

A first test was conducted on plants of Rabat071 barley variety previously treated by soaking in solutions of1.25 ml/L concentration for each of the three essential oils and water as control: four pots per treatment were sowed by 15 seeds each. This test was repeated 4 times.

A second test was carried out on a durum wheatvariety Ourgh plants previously soaked in solutions of concentration of 1.25 ml/L of the three essential oils and water as a control. Seeds were sown by 15per pot:4 pots for each treatment, the test was repeated 4 times.

A third test was done on Acssad68 barley variety plants for which seeds were soaked in solutions of 0.156 ml/L concentration from *Mentha pulegium* and *Eugenia aromatica*essential oils and water as a control. These seeds were sown in trays: with three rows per treatment, four holes per row were seeded with five seeds each; the experiment was repeatedtwice.

A fourth test was done on Acssad68 barley variety plants treated by foliar spraying with solutions of 1.25 mL/L EO-water mixture the 3 essential oils, control plants remained untreated.

Disease inoculation: *Erysiphe graminis* was naturally airborne and powdery mildew disease developed easily with greenhouse moisture[22] .

Powdery mildew disease evaluation: the disease was evaluated by the percentage of infected leaf area[22].

Statistical analyzes

Data were statistically analyzed using SPSS (Statistical Package for the Social Sciences) software and were evaluated by ANOVA (analysis of variance). A paired comparison was done with the least significant difference test at P = 0.05. The rate of disease severity reduction was calculated according to the equation (2):

$$SR(\%) = \frac{US-TS}{US} * 100. \qquad (2)$$

Where SR, US and TS represent the rate of disease severity reduction estimated in percentage, untreated controls disease severity and treated cultures disease severity respectively.

III. Results

We observed inhibition of saprophytic fungi on the seeds treated by soaking in essential oils unlike untreated controls

Influences of essential oils on seed germination

Figure no 1 shows that the concentration 1.25 ml/L of *Cedrus Atlantica* EO had no effect on seed germination of Ourgh durum wheat variety but reduced by 23% the germination of Oussama and Rabat071 barley varieties. EOs solutions of *Mentha pulegium* and *Eugenia aromatica* had drastic negative impacts on seed germination for all tested varieties.

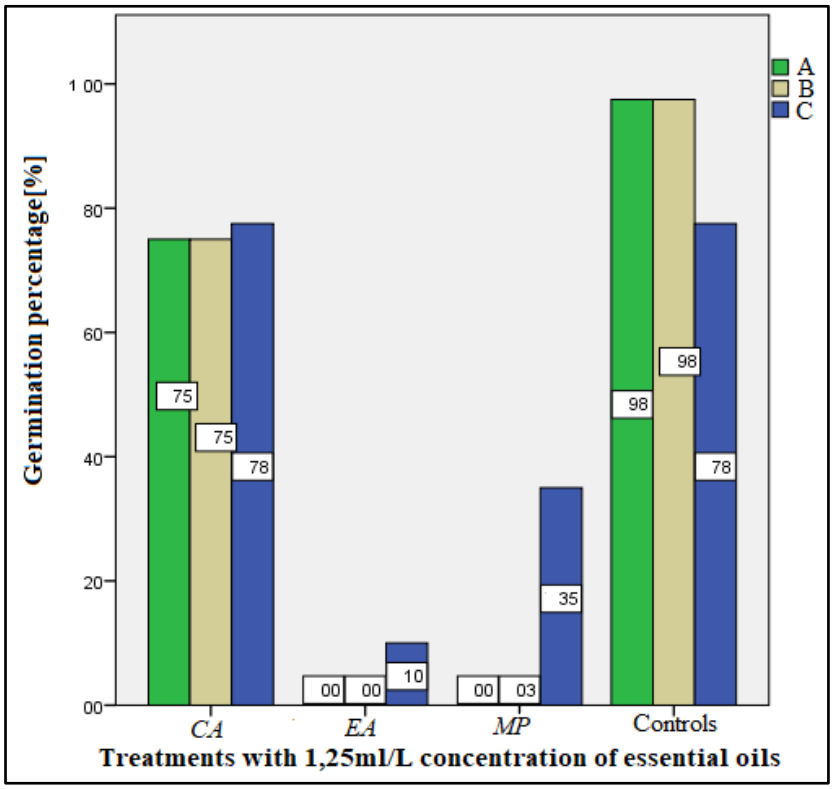

Figure no1 : Effect of soaking grain in1.25 ml/L concentration of essential oils of *Mentha pulegium (MP), Cedrus atlantica (CA)* and *Eugenia aromatica (EA)* on germination of Oussama (A), Rabat071 (B) barley varieties and Ourgh (C) durum wheat variety.

Figure no 2 shows that for varieties soaked in different dilutions namely concentrations 0.625 ml/L, 0.312 ml/L and 0,156ml/L of *Mentha pulegium* and *Eugenia aromatica* EOs, Rabat071 barley variety was the most sensitive of all because even with the lowest concentration (0.156 ml/L) germination was reduced by 67%. With Acssad68 barley variety,seeds soaked in 0.625 ml/L concentrations did not germinate, while the other concentrations did not significantly reduce germination. Similarly, Ourgh durum wheat germination was reduced by the 0.625 ml/L concentrations of both EOs and this variety was found to be more sensitive to *Mentha pulegium* EO than to *Eugenia aromatica*: compared to control the concentrations 0.312 ml/L and 0.156 ml/L of *Eugenia aromatica* EO did not affect seed germination.

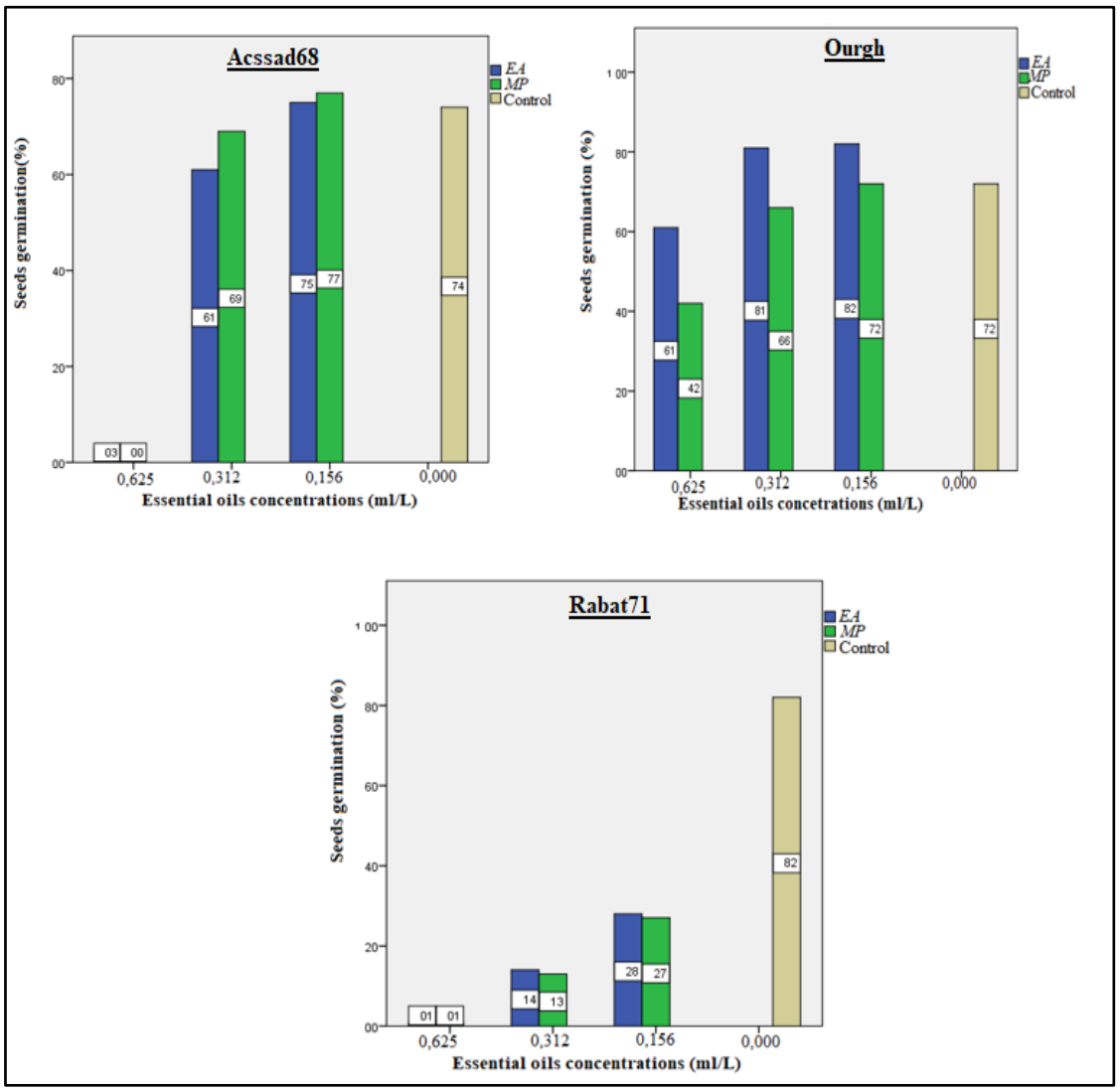

Figure no2: Effects of 0.625 mL / L, 0.312 mL / L and 0.156 mL / L concentrations of *Mentha pulegium (MP)* and *Eugenia aromatica (EA)*essential oils on seeds germination.

Table no1 shows that essential oils did not greatly affect the germination of the nine durum wheat varieties: three varieties were more sensitive; Yasmine, Karim and Jawhar for which sprouting were reduced by 34%, 25% and 19% respectively.

Table no1 :Average germination of 9 durum wheat varieties soaked in solutions 0.156 ml / L concentration of *Mentha pulegium* and *Eugenia aromatica* EO compared to untreated controls.

Variety	Average germination of treated seeds	Average germination of untreated controls	Average rate of germination reduction (%)
Annouar	0,910	0,889	-2.36
Chaoui	0,863	0,889	2.92
Irdine1804	0,786	0,829	5,18
Jawhar	**0,683**	**0,849**	**19,55**
Karim	**0,336**	**0,449**	**25,16**
Marjana	0,900	0,969	7,12
Tomouh	0,870	0,909	4,29
Waha	0,720	0,809	11
Yasmine	**0,550**	**0,829**	**33.66**

Table no 2 shows that for the 8 varieties of wheat, we noticed that compared to the control, EOs of *Mentha pulegium* and *Eugenia aromatica* had no significant effects on seed germination, Aguilal variety was the most sensitive with a germination reduction rate of 23

Table no2: Average germination of 8 soft wheat varieties soaked in solutions 0.156 ml / L concentration of *Mentha pulegium* and *Eugenia aromatica* EO compared to untreated controls.

Variety	Average germination of treated seeds	Average germination of untreated controls	Average rate of germination reduction (%)
Achtar	0,803	0,840	4.4
Aguilal	**0,737**	**0,960**	**23.3**
Amal	0,877	0,920	4.67
Elkheir	0,900	0,940	4,25
Massira	0,920	0,960	4,16
Arrihane	0,940	0,980	4,08
Salama	0,870	0,920	11,22
Tilila	0,903	0,940	3,93

Table no 3 shows that essential oils of *Mentha pulegium* and *Eugenia aromatica* had negative effects on the germination of all barley varieties; Acssad171variety was the most sensitive with the highest germination reduction rate of 60% .

Table no3: Average germination of 10 barely varieties soaked in solutions 0.156 ml/L concentration of *Mentha pulegium* and *Eugenia aromatica* EO compared to untreated controls.

Variété	Average germination of treated seeds	Average germination of untreated controls	Average rate of germination reduction (%)
Acssad176	**0,370**	**0,940**	**60.6**
Adrare	0,670	0,940	28,72
Amalou	0,587	0,900	34,77
Amira	0,533	0,960	44,47
Azilal	0,527	0,940	43,93
Ferdaous	0,640	0,860	25,58
Massine	0,610	0,940	35,1
Tamelatte	0,457	0,880	48,06
Tiddas	0,430	0,900	52,22
Tissa	0,640	0,900	28,88

Effects of essential oils on wheat crown rot diseases severity

Table no 4 shows that on Ourgh durum wheat, the effect of 1.25 ml/L treatments is significant, which means that compared to the control each treatment has acted differently from the others.

Table no4: Effects of 1.25ml/l concentrations of *Mentha pulegium*, *Eugenia aromatica* and *Cedrus atlantica* essential oils on fusariosis of Ourgh durum wheat.

Treatment	Disease		Weight of dry biomass	
	Severity	Reduction (%)	Weight (gr)	Reduction (%)
Control	3	-	6	-
Mentha pulegium	2,6	13	5	16
Eugenia aromatica	2,5	16	5	16
Cedrus atlantica	2,8	6	6	0

Table no 5 shows that the small reduction of disease by essential oils and non-reproducibility of the reduction of the disease on the biomass may be due to nitrogen fertilization that have received plants.

Table no5: Effect of 0.156ml/L concentration of *Mentha pulegium* and *Eugenia aromatica* essential oils against Fusarium wilt on barley, soft wheat and durum wheat varieties.

Species	Varieties	Treatments	Disease	
			Severity	Reduction(%)
Barley	Amalou	Control	3	-
		Mentha pulegium	3	0
		Eugenia aromatica	2	33*
	Tissa	Control	3	-
		Mentha pulegium	2,36	21*
		Eugenia aromatica	2,78	7
Soft wheat	Arrihane	Control	3	-
		Mentha pulegium	2,93	2
		Eugenia aromatica	2,77	7
	Elkheir	Control	3	-
		Mentha pulegium	2,95	1,6
		Eugenia aromatica	2,94	2

Durum wheat	Anuar	Control	2,87	-
		Mentha pulegium	2,87	0
		Eugenia aromatica	2,77	3,5
	Chaoui	Control	3	-
		Mentha pulegium	2,31	23*
		Eugenia aromatica	2,9	3,3
Note : * is Significantly different from the control at 5% probability.				

Effects of essential oils on spot blotch diseases severity

Figure no 3 shows that we observed effects of foliar spray treatments with 1.25ml/L concentrations of *Mentha pulegium*, *Eugenia aromatica* and *Cedrus atlantica* essential oils on the severity of the disease. Therefore, for each species, there was a disease reduction by essential oils of *Mentha pulegium* (50% on barley and soft wheat, 47% for durum wheat) and *Cedrus atlantica* (53% on durum wheat, 50% on barley and soft wheat). Essential oil of *Eugenia aromatica*reduced the disease by (33% on soft wheat, 20% on durum wheat and 8% on barley).

For varieties, which had their seedsdipped in EOs solutions, we did not notice any difference of disease severity between the controls and the EOs regardless of the concentrations.

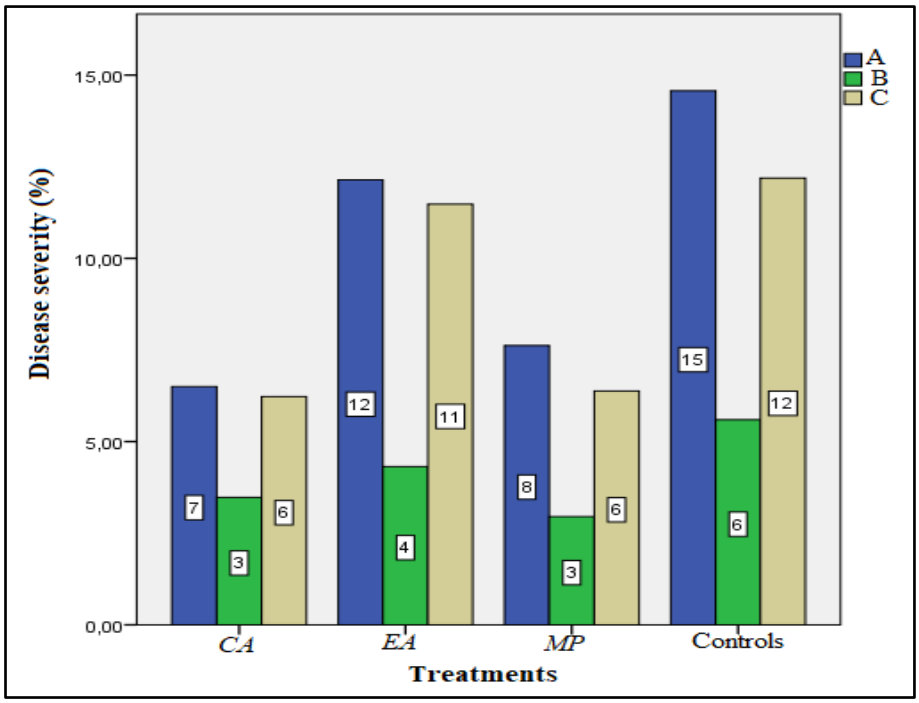

Figure no3: Effects of 1.25 ml / L concentrations of *Mentha pulegium (MP)*, *Eugenia aromatica(EA)* and *Cedrus atlantica (CA)* essential oils applied by foliar spray against the severity of helminthosporiosis on durum wheat (A), soft wheat (B) and barley (C) varieties.

Effect of essential oils on powdery mildew disease severity

On Ourgh durum wheat,only plants grown from seeds soaked in water (control) were attacked, 1.25 ml/L concentrations of *Mentha pulegium*, *Eugenia aromatica* and *Cedrus Atlantica* essential oils solutions completely inhibited the development of the disease.

Table no 6 shows that on Rabat071 barley plants,1.25 ml/L concentrations of the three essential oils reduced powdery mildew disease in different ways. We did not notice significant difference in disease severity between the two evaluations.

Table no6*:* Reduction of powdery mildew severity on Rabat071 barley plants by 1,25 ml/L concentrations of *Mentha pulegium, Eugenia aromatica* et *Cedrus atlantica* essential oils solutions.

Treatment	Disease severity(%)	Reduction(%)
control	67,031	-
Mentha pulegium	44,531	34

Eugenia aromatica	57,500	14
Cedrus atlantica	52,425	22

On Acssad68 barley, preventive treatments by foliar spray with solutions of 1.25 ml/L concentration in essential oils of *Mentha pulegium*, *Eugenia aromatica* and *Cedrus atlantica*inhibited the development of powdery mildew disease.However, treatments by soaking seeds in concentrations of 0.156 ml/L in essential oils of *Mentha pulegium* and *Eugenia aromatica* didnot reduce the disease for neither the first nor the second experiment: all the plants died. From this, we can say that foliar spray with solutions of 1.25 ml/L concentration of the three EOs was a good treatment for powdery mildew on Acssad68 barley variety.

IV. Discussion

Mentha pulegium and *Eugenia aromatica* EOs have most inhibited seed germination; this can be attributed to the allelopathy substances that are part of the components of these oils[28]. Indeed pulegone, the majority compound of *Mentha pulegium* essential oil, is a monoterpene. In fact,[29]showed the inhibitory effect induced by the monoterpenes on seeds germination. Eugenol, the majority compound of *Eugenia aromatica* EO, is a phenol and according to [30, 31], phenolic compounds act on the growth and synthesis by the regulation of growth hormones with inhibitory actions thus causing the loss of seed germination.

On wheat crown rot, with plant varieties for which seeds were soaked in concentrations of 0.156ml/Lof *Mentha pulegium* and *Eugenia aromatica* essential oils, the best reduction of disease was observed on more barley varieties; this could be attributed to the fact that barleys are more resistant wheat crown rot.

About spot blotch, obtained results are consistent with those obtained in [21] for the control of spot blotch disease by *Allium sativus*(garlic) juice at concentrations of 1000mg/L, 500mg/L and 250mg/L.

V. Conclusion

Against wheat crown rot, the best results were achieved with the treatments by soaking seeds in concentration 0.156 ml/L of EO: these are decreases by 33% with *Eugenia aromatica* EO on the Amalou barley variety;*Mentha pulegium* EO reduced by 23% the disease on Chaoui durum variety and 21% on Tissa barley variety.

Against spot blotch, by foliar spray treatment with the concentration 1.25 ml/L, *Cedrus atlantica* EO reduced disease by 53% on durum wheat varieties, 50% for barley varieties and 50% for the variety of soft wheat. *Mentha pulegium* EO reduced the disease by 50% on barley varieties, 50% on soft wheat variety and 47% on durum wheat varieties and with *Eugenia aromatica* EO we observed reduction of spot blotch by 33% on the common wheat variety, 20% on the durum wheat varieties and 8% on the barley varieties.

Powdery mildew disease was completely controlled by 1.25 ml/L concentration of the three EO on Ourgh plants durum treated by soaking seeds and on Acssad68 barley plants treated with foliar spray.On Rabat071 barley variety treated by soaking seeds, we observed decreases in disease severity by 34% with EO of *Mentha pulegium*, 22% with that of *Cedrus Atlantica* and 14% with *Eugenia aromatica* EO.

Based on results of this study, inhibition of saprophytic fungi on the seeds treated by soaking in essential oils shows that these EOs could be used in hydroponic forage and culinary sprouting. For foliar diseases, foliar spray resistance induction was best because imbibition induction showed negative effects of EOs on seed germination. Essential oils of *Mentha pulegium*, *Eugenia aromatica* and *Cedrus atlantica* have proved effective against cereal diseases and should be used as alternative to chemical fungicides.

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