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Essential Oils as Alternative Control Materials of Onion Purple Blotch Disease Caused by *Alternaria porri*

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Treatments with the fungicides against *Alternaria porri* mycelia growth were arranged according to their effectiveness in the following descending order, Ridomil gold plus 71.5 % WP, Galben copper 69.8% WP, Ridomil gold MZ-68% WG, Dithane M 45% WP and Kocide 2000 53.8% DF. The mixtures of fungicides were more efficiency than any single fungicide against mycelia growth of *A. porri*. The candidate essential oils were arranged according to their reduction percentages in mycelial growth at all tested concentrations in the following descending order, clove, cinnamon, thyme, camphor and nigella. Camphor and thyme oils have approximately the same inhibitory activity at all tested concentrations. The current study of greenhouse experiment indicated that the essential oils; camphor and thyme gave low efficiency against onion Purple blotch, while cinnamon and clove oils had approximately the same controlling effect. Generally, efficiency of Ridomil gold plus against onion Purple blotch was more than the essential oils. Mostly, efficiency results of essential oils against Purple blotch in the field through the two agricultural seasons 2017/18 and 2018/19 were compatible with those obtained in the greenhouse experiments. There are no significant differences in disease severity between the treatments of the essential oils, thyme, cinnamon and clove. Data in both seasons confirmed that camphor oil was the least efficient material. All treatments significantly increased the onion yield comparing with the untreated control. The high efficiency of Ridomil gold plus against purple blotch caused a high increase in onion yield. Meanwhile, the tested essential oils were moderately efficient and resulted in significant increase in onion yield.

Key words: Onion, *Alternaria porri*, essential oils, fungicides

Onion (*Allium cepa* L.) rightly called “kitchen queen” is one of the oldest known and important crops grown in many countries all over the world. The total cultivated area of onion in Egypt is about 196.968 fed, which produced a total production of about 2.889.520 tons in 2015, which distributed in lower Egypt (73%), middle Egypt (17%) and upper Egypt (10%) according to the statistical data obtained from the Department of Economic Statistical, Ministry of Agric. Land Rec. Report (2016).

On the other hand, onion is a crop rich in phytochemicals especially medicinal flavones (Javadzadeh *et al*., 2009 and Priya *et al.,* 2015). Egyptian onion is widely exported to many countries all over the world for its good quality and early appearance in the foreign markets. Several factors laid to its low productivity in Egypt, i.e its infection by several diseases such as downy mildew, purple blotch, stemphylium blight, white rot, basal rot, storage rots and non-availability of varieties resistant to biotic and abiotic stresses (Woudenberg *et al*., 2014). Purple blotch caused by *Alternaria porri* (Ellis) Cif. is a very important disease that affects foliage. It causes yield reduction from 30-50% (Nolla, 1927) and even up to 100% (Skiles, 1953). Leaf damages, which caused by purple blotch, are frequently observed higher in older than in younger leaves (Miller, 1983; Chethana, *et al*., 2013 and Woudenberg *et al.,* 2014).

Extensive use of chemical fungicides has led to development of resistant strains of pathogenic organisms and pollution of the environment (Garcia, 1993). Therefore, recent investigations aimed to reduce the dependency on chemical pesticides and to use safe alternatives in pest control programs. Pawar and Thaker (2008) used 75 different essential oils against *A. porri* and found that the most active essential oils were lemongrass, clove, cinnamon bark, cinnamon leaf, cassia, fennel, basil and evening prim rose. However, the effectiveness of these essential oils on the tested fungi showed different responses. Accordingly, the present work aimed to study the efficiency of essential domestic oils (cinnamon, camphor, thyme and clove) comparing with the recommended fungicide, Ridomil gold plus 71.5% WP for controlling onion purple blotch caused by *A. porri* under greenhouse and field conditions.

Materials and Methods

Source of the tested fungus

A pure culture representing the pathogenic onion fungus, *A. porri* was obtained from the Onion and Oiliness Crops Dis. Res. Dept., Plant Pathology Research Institute, Agricultural Research Center, Giza, Egypt.

Tested fungicides and essential oils

Five registered fungicides in addition to five essential oils were selected for conducting this study. Efficiency of the commercial formulations of the registered fungicides; Kocide 2000 53.8% DF (copper hydroxide), Dithane M 45-80% WP (mancozeb), Ridomil gold MZ 68% WG {(mancozeb + metalaxyl-M (mefenoxam)}, Galben copper 69.8% WP (copper oxychloride + benalaxyl), and Ridomil gold plus 71.5% WP {copper oxychloride + metalaxyl-M (mefenoxam)} at the concentrations 100, 250, 500 and 750 ppm were evaluated against the mycelia growth of *A. porri*. The tested fungicides represent different chemical groups; inorganic (copper hydroxide and copper oxychloride), carbamate (mancozeb), acylalanine (benalaxyl and metalaxyl-M). The concentrations 0.5, 1.0 and 1.5%

were used for the tested essential oils, Black seed (*Nigella sativa*), camphor (*Eucalyptus globules*), thyme (*Thymus vulgaris*), cinnamon (*Cinnamomum zeylanicum*) as well as clove (*Syzyginum aromaticum*) and tested against *A. porri* mycelia growth.

Growth inhibition measurement

The inhibitory effect of the tested fungicides and essential oils on the mycelia growth of *A. porri* was estimated on potato dextrose agar medium (PDA). A serial of concentrations for each tested fungicide and essential oil were prepared using sterilized water. Poison food technique (PFT) of Schmitz (1930) was followed for studying the efficiency of the tested fungicides and oils against mycelia growth of *A. porri.* Different quantities of the tested materials were mixed with the sterilized PMA medium after cooling at 45^{o}C before pouring. After that, it was notated gently to ensure equal distribution of the tested compounds and solidification of the medium. The fungus was seeded in the center of each Petri dish using 5 mm agar disc having active mycelia growth of *A. porri* (Hammer *et al.,* 1999). Each treatment was replicated four times in addition to a check treatment, which was free from any fungicide or essential oil. All inoculated plates were incubated at 25±1^{o}C until the fungal growth filled the fungicide-free plates. The inhibition of fungal mycelia growth in different concentrations was determined in relation to those of the control treatment using Abbott's formula (Abbott, 1925).

Greenhouse experiments

These experiments were carried out in the greenhouse of Plant Pathology Institute, ARC, Giza-Egypt. Onion seedlings of cultivar Giza 20 were used in this study. Onion seedlings (60-days-old) were obtained from Onion Research Section, ARC, Egypt. Two seedlings were planted in each pot (25-cm-diam.) filled with autoclaved clay soil. Inoculum of *A. porri* was prepared by growing on PDA medium at 25°C for 15 days. Ten ml of sterile distilled water were added to each plate and after that, the obtained colonies were carefully scraped with a sterile needle. The resulting conidial suspension of the fungus was adjusted to 5x10^{4} propagules according to El-Ganaieny *et al*. (1998) and used for spraying the onion plants. After inoculation, plants were covered with polyethylene bags for 48 hours to maintain a high level of humidity. After that, the bags were removed, and plants were kept under normal greenhouse conditions (20°C and 75-80% R.H.).

The chosen essential oils, camphor, thyme, cinnamon, and clove were applied at the rate of 1.5%, while the reference fungicide Ridomil gold plus 71.5% WP was used at the rate of 500 ppm. All treatments were applied as a foliar spraying to run-off using a hand sprayer. Super film was mixed before spraying with each treatment at the rate of 0.5 ml/1.0 L as surfactant and sticker material. Four replicates (pots) of onion plants inoculated with the tested pathogen and sprayed with water only served as a check treatment. Data were scored 15 days after spraying as disease severity according to the equation developed by El-Ganaieny *et al.* (1999).

Field trials

The experiments were carried out during the two growing seasons 2017/2018 and 2018/2019 to evaluate the efficiency of the aforementioned essential oils in addition to the reference fungicide Ridomil gold plus 71.5% WP against purple blotch in commercial fields of onion cv. Giza-20 at Etay Elbarowd county, Behera governorate. The experiment was set in a randomized complete block design with six treatments and each of which was replicated three times. Each experimental plot included six rows (each one was 3.0 m length and 50 cm width). Sixty-day-old transplants of onion were planted in each plot at the recommended spacing 10 cm x 10 cm, within each row in the first week of December (approximately 60 plants/row) to provide 360 onion plants/plot. The plots were maintained with the conventional cultural practices used in commercial fields of onion.

The candidate essential oils were applied at the rate of 1.5%, while the fungicide Ridomil gold plus 71.5% WP was used at the rate of 500 ppm. Foliar spraying was applied at a regular interval and repeated six times every two weeks (duration from 15th January to 30th March), while un-sprayed control plants were sprayed with water. All treatments were treated as foliar spraying to run-off using a back sprayer. Super film was mixed directly with spraying solution in each treatment at the rate of 5 ml/10 L as a surfactant and sticker material. The onion leaves were classified into categories 15 days after the last spray and disease severity was then calculated according to the equation developed by El-Ganaieny *et al*. (1999). Harvesting was done in the last week of May during both seasons, when 50% of plant foliage's were bended showing symptoms of ripening. Data of yield for each treatment was calculated and expressed as ton/fed.

Statistical analysis

The obtained data were subjected to the proper statistical analysis using the MSTAT-C Software (MSTAT-C, 1991), while the comparison between means was done using LSD ($P \leq 0.05$).

Results

Effect of the tested fungicides on the mycelia growth of Alternaria porri

Data concerning the inhibitory activity of the tested fungicides; Kocide 2000 53.8% DF, Dithane M 45% WP, Ridomil gold MZ-68% WG, Galben copper 69.8% WP and Ridomil gold plus 71.5 % WP at the four concentrations; 100, 250, 500 and 750 ppm against *A. porri* mycelium are presented in Table (1). All of the tested fungicides showed low efficiency against *A. porri* mycelium at the lowest concentrations, being 2.0 - 6.4% except Ridomil gold plus 71.5% WP which gave 32.5% inhibition. The reduction percentages in mycelia growth of *A. porri* treated with Kocide 2000 53.8% DF, Dithane M 45% WP, Ridomil gold MZ-68% WG, Galben copper 69.8% WP and Ridomil gold plus 71.5 % WP at 250 ppm were 5.71, 16.4, 27.75, 50.84 and 60.37%, respectively. The same efficiency trend of the tested

fungicides against mycelia growth of *A. porri* was found when the high concentrations (500 and 750 ppm) were tested. The reduction percentages of Kocide 2000 53.8% DF, Dithane M 45% WP, Ridomil gold MZ-68% WG, Galben copper 69.8% WP and Ridomil gold plus 71.5 % WP reached to 38.13, 42.57, 51.48, 100 and 100% at the highest concentration, respectively. Accordingly, Ridomil gold plus 71.5 % WP was the superior fungicide against *A. porri* mycelium, while Kocide 2000 53.8% DF was the inferior one.

Table (1): Mycelia growth (mm) and reduction % (Red.) of *Alternaria porri* treated with certain fungicides five days after incubation at 25±1°C

Fungicides	concentrations %							
	100 ppm		250 ppm		500 ppm		750 ppm	
	Linear Growth	Red. %	Linear Growth	Red. %	Linear Growth	Red. %	Linear Growth	Red. %
Kocide 2000	88.20 e	2.00	84.86 e	5.71	65.02 e	27.75	55.68 d	38.13
Dithane M	87.02 d	3.30	75.23 d	16.40	46.32 c	41.91	51.68 c	42.57
Ridomil MZ	84.24 c	6.40	65.02 c	27.75	52.28 d	48.53	43.66 b	51.48
Galben copper	65.66 b	2.70	44.24 b	50.84	24.64 b	72.62	0.00 a	100
Ridomil gold plus	60.68 a	32.50	35.66 a	60.37	0.00 a	100	0.00 a	100
Control	90.00 f	--	90.00 f	--	90.00 f	--	90.00 f	--
LSD (≤0.05)	0.72	--	0.83	--	1.45	--	0.72	--

Means followed by different letters in each column have significant differences among treatments according to LSD at 0.05.

So, the treatments were arranged according to their reduction percentages in the following descending order; Ridomil gold plus 71.5 % WP, Galben copper 69.8% WP, Ridomil gold MZ-68% WG, Dithane M 45% WP and Kocide 2000 53.8% DF. It was found that the reduction percentages of mancozeb (Dithane M 45% WP) was increased from 3.3, 16.4, 41.91 and 42.57% to 6.4, 27.75, 48.53 and 51.48% at the concentrations of 100, 250, 500 and 750 ppm, when mefenoxam was mixed with it in Ridomil gold MZ-68% WG, respectively.The results also indicated that the mixture fungicides was more efficiency than the single fungicides against the mycelia growth of *A. porri*.

Effect of candidate essential oils on the mycelia growth of Alternaria porri

Results in Table (2) show the efficiency of the tested essential oils against mycelia growth of *A. porri.* They were arranged according to their effectiveness and reduction percentage in mycelia growth at all of the tested concentrations in the following descending order, clove, cinnamon, thyme, camphor and Black seed. Values of reduction percentages due to the tested essential oils at 0.5% were 44.13, 44.07, 33.02, 32.93 and 10.73%, while their corresponding values at 1.0% were 77.01, 66.35, 55.17, 54.82 and 21.75%, respectively. The same efficiency trend of

the tested essential oils was found when the highest concentration was tested. Clove oil was the most potent essential against mycelia growth of *A. porri*, while nigella oil was the least once. Clove oil was 4 times as toxic as nigella oil. Camphor and thyme oils have approximately the same inhibitory activity at all of their tested concentrations.

Table (2): Mycelia growth (mm) and reduction % (Red.) of *Alternaria porri* treated with various concentrations % of certain essential oils five days after incubation at 25±1ºC

Essential oils used	concentrations %					
	0.5 %		1.0 %		1.5 %	
	Linear Growth	Red. %	Linear Growth	Red. %	Linear Growth	Red. %
Nigella	80.34c	10.73	70.42d	21.75	70.28d	21.91
Camphor	60.36b	32.93	40.66c	54.82	30.68c	65.91
Thyme	60.28b	33.02	40.34c	55.17	30.33c	66.30
Cinnamon	50.33a	44.07	30.28b	66.35	20.58b	77.13
Clove	50.28a	44.13	20.69a	77.01	10.39a	88.45
Control	90.00e	--	90.00e		90.00e	--
LSD (≤0.05)	1.72	--	1.56	--	1.39	--

Means followed by different letters in each column have significant differences among treatments according to LSD at 0.05.

Greenhouse evaluation

This experiment was conducted under artificial inoculation with *A. porri* spores to evaluate the efficiency of the chosen essential oils in addition to Ridomil gold plus 71.5 % WP against onion purple blotch under greenhouse conditions (Table 3). All candidate essential oils, when used at the rate of 1.5%, were effective in reducing the disease severity of onion purple blotch. Disease severity in the check treatment reached to 73.24%. Purple blotch was developed extensively on onion plants of the check treatment in comparison to the treatments of essential oils and fungicide. Significant differences were found between disease severity of purple blotch in all treatments and control. All the candidate essential oils were effective at different levels in reducing the disease severity of onion purple blotch. Disease severity percentages in treatments of camphor, thyme, cinnamon, clove and Ridomil gold plus, were 69.43, 56.12, 40.33, 39.58 and 22.76, respectively. The corresponding values of efficiency percentages were 5.20, 23.37, 44.93, 45.95 and 68.92%, respectively. Camphor and thyme oils gave low efficiency against onion purple blotch, while cinnamon and clove oils showed approximately the same controlling values (moderate efficiency). Generally, efficiency of Ridomil gold plus was more effective against onion purple blotch than essential oils.

Table (3): Effect of certain essential oils in addition to the fungicide Ridomil gold plus 71.5 % WP sprayed against onion purple blotch caused by *Alternaria porri* under greenhouse conditions.

Treatments	Disease severity %	Efficiency %
Camphor	69.43	5.20
Thyme	56.12	23.37
Cinnamon	40.33	44.93
Clove	39.58	45.95
Ridomil gold plus	22.76	68.92
Control	73.24	---
LSD (P≤0.05)	2.81	---

Field evaluation

Results in Table (4) show the disease severity percentages of purple blotch on onion 14 days after the last spray with each of the essential oils; camphor, thyme, cinnamon, clove and Ridomil gold plus during 2017/2018 and 2018/2019 in addition to the means of efficacy percentage for the two seasons. These experiments were carried out in the winter seasons. These weather conditions were favorable for purple blotch, which resulted in a high natural infection in check treatment. The disease severity percentages reached to 50.34, 36.65, 36.33, 33.03 and 22.76% in the treatments of camphor, thyme, cinnamon, clove and Ridomil gold plus, during the first season 2017/2018, respectively. The corresponding values in the second season 2018/2019 were 58.46, 54.12, 55.07, 51.68 and 20.33%, respectively. Disease severity percentages in the second season were more than those in the first season in all treatments especially in the control treatment, which was increased from 56.72 to 74.70%.

Table (4): Effect of certain essential oils in addition to the fungicide Ridomil gold plus 71.5 % WP sprayed against onion purple blotch caused by *Alternaria porri* under field conditions during seasons 2017/18 and 2018/19 growing seasons.

Treatments	Disease severity %			Efficiency (%)
	2017/18	2018/19	Mean	
Camphor	50.34	58.46	54.40	17.21
Thyme	36.65	54.12	45.39	30.92
Cinnamon	36.33	55.07	45.70	30.45
Clove	33.03	51.68	42.36	35.53
Ridomil gold plus	22.76	20.33	21.54	67.22
Control	56.72	74.70	65.71	---
LSD (P≤0.05)	--	--	2.81	---

Data in both seasons showed that camphor oil was the least efficiency against purple blotch on onion, where mean of disease severity in both seasons reached to 54.40% comparing with 65.71% in the control treatment. This finding is compatible with its efficiency in the greenhouse experiment. Mostly, there were no significant differences in disease severity among the treatments of thyme, cinnamon and clove, where it ranged between 42.36 and 45.70%. It was also found that Ridomil gold plus was significantly more efficient than the candidate essential oils for controlling onion purple blotch under field conditions.

The efficiency percentages of camphor, thyme, cinnamon, clove oils and Ridomil gold plus against purple blotch were 17.21, 30.92, 30.45, 35.53 and 67.22%, respectively. Thyme and cinnamon oils had approximately the same controlling values with moderate efficiency. Generally, efficiency of Ridomil gold plus against onion purple blotch was more than the tested essential oils.

Results in Table (5) indicate that all the treatments significantly increased the yield of onion compared to the untreated control. There were no significant differences in onion yield among the tested essential oils within the first and the second seasons. A slight decrease in onion yield was occurred during the second season 2018/2019. In the first season, onion yield ranged between 9.13 and 9.93 tons/fed in the treatments of essential oils compared with 7.42 tons/fed in the control, represented an increase in onion yield around 28.30 and 33.83%. increment in onion yield of Ridomil gold plus treatment reached to 45.42%. The same trend of onion yield was found in the second season. Mean of onion yield through the two seasons ranged between 8.77 and 9.30 tons/fed in the treatments of essential oils, while it was 11.21 tons/ fed when Ridomil gold plus was used. The high efficiency of Ridomil gold plus against purple blotch is due to high increase in the onion yield. On contrary, the essential oils showed moderate efficiency resulted in remarkable increase in onion yield.

Table (5): Onion yield (tons/fed) and its increase % in treatments of essential oils as well as the fungicide Ridomil gold plus during 2017/2018 and 2018/2019 growing seasons.

Treatments	2017/18		2018/19		Mean	
	yield (tons/fed.)	Increase (%)	yield (tons/fed.)	Increase (%)	(tones/ fed)	Increase (%)
Camphor	9.13b	23.05	8.40b	32.49	8.77	27.47
Thyme	9.93b	33.83	8.33b	31.38	9.13	32.70
Cinnamon	9.52b	28.30	8.78b	38.49	9.15	32.99
Clove	9.81b	32.21	8.78b	38.49	9.30	35.17
Ridomil gold plus	10.79c	45.42	11.62c	83.28	11.21	62.94
Control	7.42a	---	6.34a	---	6.88	---
LSD (P≤0.05)	0.58	---	0.63	---	---	---

Means followed by different letters in each column have significant differences among treatments according to LSD at 0.05.

Discussion

The strategy of pest management, especially on vegetables depends on using alternative safe methods rather than chemical pesticides. Therefore, agricultural scientists recommended using such chemicals at the first period of plant growth prior to the fruit maturity to give a chance for chemical degradation before harvesting.

On the other hand, the present results proved the possibility of using certain essential oils especially clove and that agrees with the findings of Antonov *et al*. (1997); Walter *et al*. (2001); EI-Kaffash, Pawar and Thaker (2008) and Fayzalla *et al*. (2011) who reported that clove oil suppressed *F. oxysporum, R. solani and B. cinerea*. The high antimicrobial activity of clove oil is probably related to Eugenol (hydroxy-3-methoxyallylbenzene) as a major compound, which exhibits broad antimicrobial activities as well as to caryophyllene, and tannins as reported by Velluti *et al.* (2003). Also, Nostro *et al.* (2004) and Rajkovic *et al.* (2005) found other compounds in clove oil, have antifungal and antibacterial activities especially carvacrol and thymol.

Moreover, Ranasingh *et al*. (2002); Pawar and Thaker (2008) and Fayzalla *et al.* (2011) reported that cinnamon has antifungal activity against plant pathogenic fungi. However, Fayzalla *et al.* (2011) found that cinnamon inhibited the radial growth of *F. oxysporum, F. proliferation, A. flavus* and *Colletotrichuim musae*. Antifungal activity of cinnamon oil may be attributed to having some active compounds such as Eugenol (the main compound of cinnamon oil), benzyl alcohol, cinnamic acid, cinnarnyl acetate, 4-hydroxybenzaldehyde and salicylaldebyde as well as 2 d-phenothrin pyrethrum and cinnamaldhyde (Young-Cheol Yang *et al.,* 2005).

In general, the antifungal activity of an essential oil may attribute to the presence of an aromatic nucleus and phenolic OH group, which is known to be reactive and can form hydrogen bonds with active sites target enzymes (Velluti *et al.,* 2003). The present results revealed that thyme oil gave high inhibition in the mycelial growth of *A. porri* at all tested concentrations. This finding agrees with the results of Fayzalla *et al.* (2011) who found that thyme oil and its major individual aroma constituents at different ratios inhibited the mycelia growth of the tested fungi belonging to genera *Aspergillus*, *Penicillium*, *Alternaria*, *Ulocladium*, *Absidia*, *Mucor*, *Cladosporium*, *Rhizopus*, and *Chaetomium*.

In greenhouse experiments, it was observed that Ridomil gold plus and Clove oil were the best treatments for suppressing disease severity caused by *A. porri* followed by cinnamon oil. Similar observations were noted by Marois and Mitchell (1981); Edris and Farrag (2003) and Sheng-Hsien Lee *et al.* (2007). The effect of essential oils under greenhouse conditions may act as a general biocide to *A. porri* and it can be hypothesized that they may have a reducing effect on rapid colonization of the pathogen. When the active ingredient, in each essential oil, is

released from the plant, it might be in a direct contact with the pathogen, so they could inhibit the activity of these pathogens away from the host and its inocula loss the ability to continue root infection. Meanwhile, Ridomil gold plus was the most efficient material against purple blotch as compared with untreated control. These results are in agreement with those obtained by Gupta *et al.* (1996); Kankwatsaa *et al.* (2003); Evenhuisa *et al.* (2006) and Fayzalla, *et al.* (2011). High antifungal activity of Ridornil gold plus may attribute to the systemic action as a fungicide. On the other hand, the previous studies revealed that metalaxyl was superior to control purple blotch especially on onion.

Under field conditions, it was also observed that the best reduction of disease severity was achieved by using Ridomil gold plus and Clove oil as compared with untreated control. On the other hand, this was followed by cinnamon oil. Conversely, camphor oil was the lowest oil for reducing disease severity. Accordingly, it can be concluded that Ridomil gold plus and clove oil caused an efficiency of 67.22 and 35.53% reduction in disease severity, respectively. Also, Ridomil gold plus and clove oil recorded the highest total onion yield, followed by cinnamon oil. Similar results were obtained by Evert and Lucy (1996). On the contrary, onion treated with camphor oil gave the lowest yield as compared with onion treated with other materials. These results are consistent with those of Marois and Mitchell (1981) and Edris and Farrag (2003).

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الزيوت الطيارة كبدائل لمكافحة مرض اللطخة الإرجوانية على البصل الذي يسببه الفطر *Alternaria porri*

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يعتبر البصل أحد أهم محاصيل الحقل ولكنه يصاب بالعديد من الأمراض الهامة مثل اللطعة الإرجوانية الذي يسببه الفطر *Alternaria porri*. تحت ظروف المعمل تم دراسة تأثير المبيدات الفطرية رودوميل إم زد-68%، دياثين إم ٤٥%، جالبن النحاس ٦٩,٨%، كوساید ٢٠٠٠- ٥٣,٨%، ريدوميل جولد بلس ٧١,٥% على معدل نمو الفطر *Alternaria porri*. أوضحت النتائج أن هناك خفضاً معنويا لمعدل نمو الفطر بعد خمس أيام من المعاملة وخاصة مع استخدام ريدوميل جولد بلس وجالبن النحاس حيث كانا أفضل المبيدات محل الاختبار في خفض معدل النمو الفطري بالمقارنة بالغير معاملة.

وعلى الجانب الآخر أحدثت كل التركيزات المختبرة للزيوت الطيارة المختبرة مثل زيت القرنفل والقرفة والكافور والزعتر وحبة البركة خفضاً في معدل نمو فطر *Alternaria porri* مقارنة بالغير معاملة. كما أعطى زيت القرنفل وزيت القرفة خفضاً في معدل النمو الفطري متبوعاً بزيت الكافور. ومن ناحية أخرى وتحت ظروف الصوبة والحقل المفتوح تم دراسة فاعلية الزيوت النباتية والمبيد الفطري ريدوميل جولد بلس (نظرا لبيان فعاليته في تجارب المعمل) في مكافحة مرض اللطخة الإرجوانية وأثرها على كمية محصول البصل بعد المعاملة حيث تم إستخدام الزيوت الطيارة بمعدل ١,٥% والمبيد الفطري بمعدل ٥٠٠ جزء في المليون. وتحت ظروف الصوبة والحقل تم تقييم فعالية كلا من نسبة وشدة الإصابة بمرض اللطخة الإرجوانية فأوضحت النتائج أن المبيد الفطري ريدوميل جولد بلس ٧١,٥% قد أعطى أعلى خفض في نسبة وشدة الإصابة بالمقارنة ببقية الزيوت النباتية وكذلك المقارنة الغير المعاملة. كما أعطى كل من زيت القرنفل وزيت القرفة نتيجة ممتازة في خفض نسبه وشدة الإصابة مقارنة ببقية المعاملات بالزيوت الأخرى. وتحت ظروف الحقل في مركز إتياي البارود بمحافظة البحيرة تمت الدراسة خلال موسمي النمو ١٨/٢٠١٧ و ١٩/٢٠١٨ تحت ظروف العدوى الطبيعية للبصل. فأوضحت النتائج أن جميع المعاملات بالمبيد الفطري والزيوت محل الدراسة أدت إلى خفض نسبة وشدة الإصابة بالمرض الفطري مقارنة النباتات المقارنة غير المعاملة. وعلاوة على ذلك كان كل من المبيد الفطري ريدوميل جولد بلس وزيت القرنفل والقرفة أعلى المعاملات خفضاً لنسبة وشدة الإصابة بالمرض مقارنة بالكونترول. أما عن كمية محصول البصل الناتج من المعاملة بالمبيد الفطري والزيوت العطرية مقارنة بغير المعاملة ، أظهرت النتائج أن المبيد الفطري ريدوميل جولد بلس وجميع الزيوت الطيارة محل الدراسة أدت إلى زيادة ملموسة في كمية محصول البصل مقارنة بالمحصول في النباتات المقارنة الغير المعاملة.