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Effect of Sodium Bicarbonate and Oils on Powdery Mildew of *Matricaria chamomilla*.

Karima G. Helmy
Department of Plant Pathology Department, Faculty of Agriculture,AinShames Univ.

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ABSTRACT

The effect of Sodium bicarbonate and three oils namely; garlic, anise and mineral oil individually and combination of Sodium bicarbonate + mineral oil were tested for their effect on powdery mildew of *Matricaria chamomilla* under greenhouse and field conditions. Disease severity was significantly reduced by all treatments in both greenhouse and field. Flowers number in greenhouse under infection of powdery mildew disease was highly significant in treatment with $NaHCO_3$ + mineral oil followed by Garlic oil and $NaHCO_3$. Fresh weight of flowers was significantly higher in $NaHCO_3$+ mineral oil followed by Garlic oil (5.24 and 3.45 g) compared to control (1.7g) respectively. On the other hand, dry weight was increased significantly in treatment with $NaHCO_3$ followed by Garlic oil (0.81 and 0.54g) compared to control (0.21g) respectively. Effect of sodium bicarbonate and oils on flowers fresh and dry weight and plant height under natural infection of powdery mildew in the field, was significantly increased in treatment with $NaHCO_3$ + mineral oil followed by $NaHCO_3$ (663.13 and 451.13g) compared with control (220.77g); respectively. Dry weight of flowers after 2 weeks was highly significant in treatment with $NaHCO_3$ followed by Anise oil (120.67 and 94.33g) compared to control (41.67g); respectively. On the other hand, after 4 and 6 weeks treatment with $NaHCO_3$ + mineral oil was the best treatment in fresh and dry weight followed by Anise oil.

Keywords: Powdery mildew – *Matricaria chamomilla* – Plant extract – oils- $NaHCO_3$

INTODUCTION

Chamomile '*Matricaria chamomilla* L.' plant is one of the most important medicinal and aromatic plants worldwide and in Egypt (El- Morsy *et al*., 2013). Chamomile plant, belonging to family Asteraceae (Compositae), mainly cultivated for obtaining the dry fluorescence that containing essential oil which is used in several medicinal industries and preparations of cosmetics compounds (Reda *et al*., 1999). Powdery mildew disease is considered one of the most important diseases attacking chamomile plant in its different cultivated areas. This disease was detected in Egypt for the first time in 1970 (Hilal *et al*., 1998). Two powdery mildew genera have been reported to infect *M. chamomilla* (Braun, 1987). *Podosphaera fusca*, *Sphaerotheca fusc* and *S. fuliginea* has been recorded in Canada, Egypt, Germany, Switzerland, USSR (Farr and Rossman, 2009).

Chamomile powdery mildew frequently occurs in the open field, estimated percentages of infection reaching 20-80% (El- Morsy *et al*., 2013). In severe infection, diseased plant seems as covered with layer form talk powder and this causes great damage especially for flowers which the important part of the plant, so the disease has negative effect on the quantity and quality of inflorescences yield regarded to the major purpose of chamomile plantation, all the possible procedures should be considered to manage it. The use of fungicides against plant diseases causes several problems such as carcinogenicity, development of fungicidal resistance and phytotoxicity as well as adverse effects of human health and environmental balance. Thus, it is urgent to apply alternative safe efficient methods against plant diseases. Recently, plant extract, and vegetable oils, such as neem (*Azadirachta indica*) and garlic (*Allium sativum*) has been used on powdery mildew fungi (Singh *et al*., 1991; Daayf *et al*., 1995; Abd-El-Sayed, 2000 and Tohamy *et al*., 2002). Different attempts were carried out to control of powdery mildew disease by sodium bicarbonate (Lahoz *et al*, (2000) and Salamone *et al,* (2009)). Sodium bicarbonate and oil combination were effective in controlling powdery mildew disease (Horst *et al*., 1992).

The objective of this study was investigating the efficacy of different oils and sodium bicarbonate in controlling powdery mildew disease of chamomile under greenhouse and field conditions.

MATERIALS AND METHODS

The tested treatments used in this study and its concentrations were listed in Table (1):

Garlic oil and Anise oil were obtained from El-Captain Company for Extracting Natural Plant oils Cairo, Egypt. Sodium bicarbonate ($NaHCO_3$) Manufactured by El Nasr Pharmaceutical chemicals Co. Abu Zaabal, Egypt

Garlic extraction:

Garlic (*Allium sativum*) bulb, 100 g of plant material were cut, placed in a blender insterilized distilled water at the ratio of 1:1 w/v and blended for 10 minutes. The plant material residues were filtered through cheesecloth. The filtrate was centrifuged (3000 rpm) for 10 min. and separated to obtain the extract (Abd-El-Sayed, 2000).

Table 1. Treatments and concentration of compounds under study.

Treatments	Concentrations
Garlic extract	20%
Garlic oil	8m/L
Anise oil	1m/L
Mineral oil	1m/L
$NaHCO_3$	4gm/L
$NaHCO_3$+ Mineral oil	4gm/L + 1ml/L

Greenhouse experiments:

Chamomile seedlings of two months old were transplanted in 30 cm pots, one seedling per pot and eight replicates for each treatment. After 50 days of transplant plants were sprayed with prepared concentrations of different compounds in advance to inoculation with the pathogen. Spraying was repeated three times with 15 days intervals. Randomized complete block design experiment was applied to all

treatments and statistical analysis for recorded data was done. Control treatment was sprayed with water only.

Artificial inoculation technique:

Chamomile plants were inoculated with the pathogen conidia. Inoculation was accomplished by shaking or gently brushing of infected samples with powdery mildew conidia over the healthy plants. Inoculated plants were kept under greenhouse conditions and were examined daily.

Field experiment:

After three weeks of transplant; all chamomile plants grown under open field conditions were triple sprayed by the six treatments. Treatments were repeated two times every two weeks. Control treatment was water sprayed only.

Yield parameters

Effect on plant growth:

Morphological parameters include; plant height (cm), flowers number, fresh and dry weight (g/plant) were recorded in both greenhouse and field experiments.

Disease severity assessment:

The percentage of disease severity was calculated 10 days after inoculation using the disease scale levels from 0 to 4 after Whitney *et al*., (1983) as follow:

Where:

0 = No mildew colonies observed.
1 = 1 to 25% of plant area covered with mildew.
2 = 26 to50% of plant area covered with mildew.
3 = 51 to 75% of plant area covered with mildew.
4 = 76to 100% of plant area covered with mildew

$$\text{Disease severity (\%)} = \frac{[\sum (\text{rating no.}) \times (\text{no. leaves in rating category}) \times (100)]}{(\text{Total no. leaves}) \times (\text{highest rating value})}$$

The percentage of treatment efficiency in the reduction of powdery mildew severity was calculated using the following equation:

$$\text{\% Efficiency} = \frac{\text{Control} - \text{Treatment}}{\text{Control}} \times 100$$

Statistical analysis:

Data in this study were subjected to one way analysis of variance (ANOVA) followed by means separation through least significant difference (L.S.D.) test at $P < 0.05$ level (Snedecor and Cochran, 1980).

RESULTS

Greenhouse experiment:

Data presented in Fig (1) illustrated the effect of sodium bicarbonate ($NaHCO_3$) and oils on powdery mildew disease severity progress in greenhouse, where all treatments were significantly reduced disease severity progress through the time compared to control, the most effective treatment in reduction disease severity was $NaHCO_3$ + mineral oil combination followed by Garlic extract. On the other hand, data in Table (1) indicated that all treatments were higher significant, compared to control. Data showed that treatment with $NaHCO_3$ + mineral oil combination was more effective followed by Garlic extract and mineral oil (72.37, 65.76 and 63.8%) compared to control (0.00%); respectively.

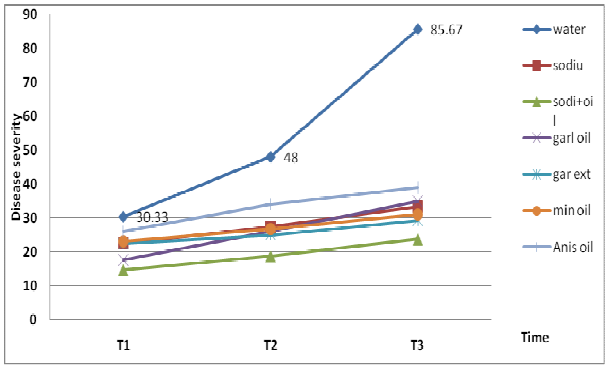

Fig. 1. Effect of sodium bicarbonate and oils on powdery mildew disease severity progress of chamomile under greenhouse condition. (T1: after two weeks, T2: after four weeks and T3: after six weeks from treatments).

Data presented in Table (3) showed that sodium bicarbonate and oils were effective on flowers number, fresh and dry weight in greenhouse under infection of powdery mildew disease. Flowers number showed significant increase in treatments with $NaHCO_3$ + mineral oil followed by Garlic oil and $NaHCO_3$ (11.15, 6.42 and 5.33) compared to control (2.80); respectively. Fresh weight of flowers was increased significantly when $NaHCO_3$+ mineral oil combination used (5.24g) followed by garlic oil (3.45 g) compared to control (1.7g); respectively. On the other hand, dry weight was increased significantly in treatment with $NaHCO_3$ followed by garlic oil (0.81 and 0.54g) compared to control (0.21g); respectively.

Table 2. Effect of sodium bicarbonate ($NaHCO_3$) and oils on powdery mildew disease severity of chamomile plants and efficiency under greenhouse condition.

Treatments	%Disease severity	%Efficiency
$NaHCO_3$	33.33^{cd} ±1.25	61.09
$NaHCO_3$+ Mineral oil	23.67^{f} ±0.94	72.37
Garlic oil	35.00^{c} ±1.41	59.15
Garlic extract	29.33^{e} ±0.47	65.76
Mineral oil	31.00^{de} ±1.63	63.81
Anise oil	39.00^{b} ±0.82	54.48
Water	85.67^{a} ±1.25	0.00
L.S.D.	2.51	

Data presented as the means of three replicates ± SD. Different letters refer to significant difference ($P \leq 0.05$).

Table 3. Effect of sodium bicarbonate ($NaHCO_3$) and oils on flowers number, fresh and dry weight of chamomile plants in greenhouse under infection of powdery mildew disease.

Treatments	Flowers number/ plant	fresh weight	Dry weight
$NaHCO_3$	5.33^{b} ±0.42	1.55^{c}±0.24	0.45^{c} ±0.02
NaHCO3+ Mineral oil	11.15^{a}±0.82	5.24^{a} ±0.14	0.81^{a} ±0.03
Garlic oil	6.42^{b} ±0.85	3.45^{b}±0.05	0.54^{b} ±0.02
Garlic extract	3.40^{c} ±0.74	1.46^{c} ±0.09	0.27^{d} ±0.01
Mineral oil	3.68^{c} ±0.84	1.75^{c} ±0.15	0.26^{de} ±0.02
Anise oil	3.42^{c} ±0.85	1.53^{c} ±0.29	0.27^{d} ±0.01
Water	2.80^{c} ±0.47	1.7^{c} ±0.16	0.21^{e} ±0.01
L.S.D.	1.57	0.38	0.05

Data presented as the means of three replicates ± SD. Different letters refer to significant difference ($P \leq 0.05$).

Field experiment:

Data in Fig (2) illustrated the effect of sodium bicarbonate ($NaHCO_3$) and oils on powdery mildew disease severity progress in greenhouse. All treatments reduced disease severity progress significantly through the time compared to control, the most effective treatment in disease severity reduction was $NaHCO_3$ + mineral oil combination followed by anise oil then mineral oil. On the other hand, data found in Table (4) indicated that all treatments under the study had a significant efficiency in disease severity reduction compared to control. Data showed that $NaHCO_3$ + mineral oil treatment was more effective followed by garlic extract and garlic oil (72.00, 65.82 and 64.73%); respectively compared to control (0.00%).

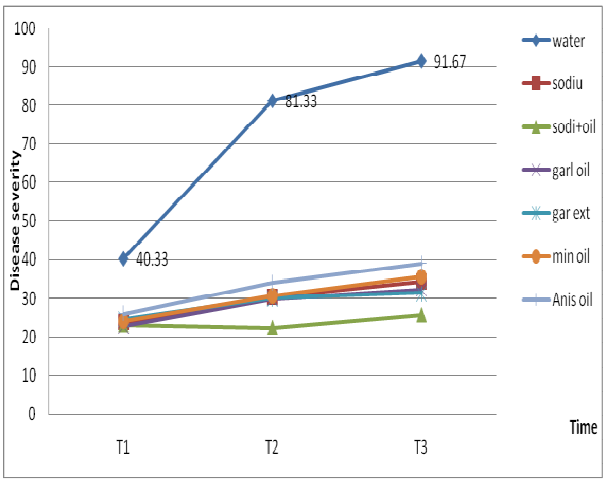

Fig. 2. Effect of sodium bicarbonate ($NaHCO_3$) and oils on powdery mildew disease severity progress of chamomile under natural infection in the field. (T1: after two weeks, T2: after four weeks and T3: after six weeks from treatments).

Table 4. Effect of sodium bicarbonate ($NaHCO_3$) and oils on powdery mildew disease severity of chamomile plants and efficiency under natural infection in the field.

Treatments	% Disease severity	% Efficiency
$NaHCO_3$	34.33^{c} ±2.05	62.55
$NaHCO_3$+ Mineral oil	25.67^{d} ±2.87	72.00
Garlic oil	32.33^{c} ±2.05	64.73
Garlic extract	31.33^{cd} ±2.05	65.82
Mineral oil	35.67^{c} ±2.87	61.09
Anise oil	47.33^{b} ±2.62	48.37
Water	91.67^{a} ±4.65	0
L.S.D.	6.15	

Data presented as the means of three replicates ± SD. Different letters refer to significant difference (P ≤ 0.05).

Data presented in Table (5) demonstrated the effect of sodium bicarbonate ($NaHCO_3$) and oils on fresh and dry weight of flowers and plant height under natural infection of powdery mildew disease in the field. Fresh weight of flowers after 3 weeks was significantly increased in $NaHCO_3$ + mineral oil treatment followed by $NaHCO_3$ only (663.13 and 451.13g) compared with control (220.77g); respectively. Dry weight of flowers after 2 weeks was showed significant increase in $NaHCO_3$ + mineral oil treatment followed by anise oil (120.67 and 94.33g); respectively compared to control (41.67g). On the other hand, after 4 and 6 weeks plants treated with $NaHCO_3$ + mineral oil was the best treatment in fresh and dry weight followed by anise oil.

All treatments led to significant increase in plant height, treatment with $NaHCO_3$ + mineral oil gave higher significant increase (114.87 g) followed by $NaHCO_3$ (110.80g) compared to control (91.60); respectively.

Table 5. Effect of sodium bicarbonate (NaHCO3) and oils on flowers fresh and dry weight and height of chamomile plants under natural infection of powdery mildew in the field.

Treatments	After two weeks		After four weeks		After six weeks		
	Flowers fresh weight	Flowers Dry weigh	Flowers fresh weight	Flowers Dry weigh	Flowers fresh weight	Flowers Dry weigh	Plant height
$NaHCO_3$	451.13^{b} ±1.65	94.33^{b} ±0.94	305.67^{d} ±4.19	82.33^{c} ±2.05	402.00^{c} ±2.16	101.67^{c} ±1.70	110.80^{b} ±0.94
$NaHCO_3$+ Min. oil	663.13^{a} ±1.44	120.67^{a} ±0.94	591.33^{a} ±2.62	115.00^{a} ±1.63	673.00^{a} ±1.63	124.00^{a} ±2.45	114.87^{a} ±2.19
Garlic oil	245.23^{f} ±1.16	54.33^{d} ±0.94	234.33^{f} ±2.49	60.33^{f} ±1.25	305.00^{d} ±4.08	93.67^{d} ±1.25	96.67^{d} ±1.42
Garlic extract	381.73^{c} ±1.28	74.00^{c} ±1.41	319.67^{c} ±2.05	75.33^{d} ±1.25	249.33^{e} ±2.49	66.00^{e} ±2.45	92.70^{e} ±0.50
Mineral oil	254.40^{e} ±1.68	44.33^{f} ±0.94	268.33^{e} ±1.69	69.67^{e} ±1.25	230.00^{f} ±0.82	94.33^{d} ±1.70	94.80^{de} ±1.55
Anise oil	276.73^{d} ±1.36	51.33^{e} ±0.94	350.33^{b} ±2.05	90.00^{b} ±1.63	411.67^{b} ±1.70	110.33^{b} ±2.05	107.07^{c} ±2.15
Water	220.77^{g} ±1.30	41.67^{f} ±2.36	222.33^{g} ±1.70	50.00^{g} ±0.82	210.67^{g} ±1.70	52.33^{f} ±2.05	91.60^{e} ±1.23
L.S.D.	3.04	2.81	3.26	3.13	4.91	4.27	3.29

Data presented as the means of three replicates ± SD. Different letters refer to significant difference (P ≤ 0.05).

DISCUSSION

In the present study disease severity was significantly reduced in all treatments in both greenhouse and field compared to control. Qvarnstrom (1992) stated that sprayed cucumber plants with 5% emulsion of garlic extract at 7 days intervals, reduce the infection with *E. cichoracearum*.

The results obtained in this study are in agreements with the findings of the following researchers who used similar compounds to control powdery mildew on other hosts.

Rovesti *et al.* (1992) found that, aqueous neem kernel extract was as effective as sulfur against powdery mildew of courgettes, wheat and barley. They found also that, neem extract gave significant control on *Puccinia recondita* f.sp. *tritici*. Reimers *et al*. (1993)

found that a compound derived from garlic (*Allium sativum*), protected some plants against powdery mildew disease.

Ahmed (1995) reported that garlic extract was more effective in inhibiting powdery mildew disease caused by *S. fuliginea*.

Nikolov and Andreev (1997) found that spraying rose plants with unrefined cotton-seed oil at rates of 0.5-2% reduced the powdery mildew disease incidence. Abd-El-Sayed (2000) demonstrated that the foliar application of some plant extracts (thyme, henna, eucalyptus and garlic) individually or mixed decreased powdery mildew on cucumber than control. Tohamy *et al.* (2002) reported that cucumber plants which sprayed with plant extracts of garlic and neem gave a significant reduction in powdery mildew disease incidence and severity.

Ohtsuka *et al.* (1991) observed that ultra structural alterations induced by spraying inoculated cucumber seedlings with machine oil suspension included deformation of the *Sphaerotheca fuliginea* hyphae, separation of the hyphal plasma membrane and degeneration of the cytoplasm, leading to death of the treated hyphae.

Collina (1996) evaluated the effect of mineral oil on powdery mildew disease of squash, and the results indicated that mineral oil was significantly reduced the disease. Steinhauer and Besser (1997) found that vegetable oils have significantly reduced the formation of powdery mildew pustules and their size on cucumber plants.

Yohalem (1997) stated that management of grey mould (*Botrytis cinerea*) and powdery mildews in tomatoes, cucumbers and potted roses can be achieved when applied rapeseed oil amended with either sodium bicarbonate or an emulsifier.

Wojdyla (2002) reported that Paraffin oil was better in the control of rose powdery mildew than the vegetable oils.

The inhibitory effect may be attributed to the formation of a physical barrier which prevent fungal penetration and reduced disease incidence also, it formed a continuous membrane which permits diffusion of oxygen and carbon dioxide and inhibits the passage of water and promotes a healthy physiological state of the plant this is agreement with the Opinion of Ziv, 1983 and Han, 1990.

Samane and Mohammad (2012) found that four oils i.e., anise, ammi, ziziphora and cinnamon inhibited the growth of *B. cinerea* and showed strong impact on post-harvest decay and fruit quality of peach.

It has been recently verified experimentally that sodium bicarbonate have antifungal activity (Lahoz *et al*, 2000), and showed a positive effect on rose plants against *S. pannosa* and black spot diseases (Horst *et al*., 1992 and Salamone *et al.,* 2009),on powdery mildew of sweet red pepper (Fallik *et al*, 1997).

The findings were explained by previous authors who stated that oils have important ecological functions; the first one to protect the plant against pathogen infection (Taiz and Zeiger, 1991 and El-Kazzaz *et al*., 2003), the other one that the essential oils contained specific components, antifungal compounds and fungi toxic agents that can inhibit the growth of many pathogens (Farag *et al*., (1989), Zambonelli, (1996), El-Shoraky, (1998), Chao *et al*., (2000), El-Shazly, (2000), Abd El-Kader *et al*., 2003, Voda *et al*., 2003, Moleyar and Narasimham, 2004, Sheng *et al*., (2005) andKrishna Kishore and Pande, (2007)).

In the present study, all tested plant oils increased the fruit number/plant and fruit weight/plant this agreement with Ahmed, (2004)

COCLUSION

The treatment with $NaHCO_3$ and mineral oil combination was the most effective in reduction of powdery mildew disease severity in greenhouse and field, so it could be suggested that combined treatments between sodium bicarbonate and mineral oil be used for controlling powdery mildew disease of chamomile plants under field conditions.

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تأثير بيكربونات الصوديوم والزيوت على البياض الدقيقى على البابونج.

كريمة جابر حلمى

قسم أمراض النبات ـكلية الزراعة جامعة عين شمس.

تم دراسة تأثير بيكربونات الصوديوم والزيوت على البياض الدقيقي فى البابونج تحت ظروف الصوبة والحقل، وجد ان المعاملات ادت الى خفض شدة الاصابة بشكل كبير في كل المعاملات في كلا من الصوبة والحقل، تم تقدير عدد الازهار، الوزن الرطب والجاف في الصوبة تحت ظروف العدوى الصناعية لمرض البياض الدقيقي، كان عدد الازهار كبير بدرجة معنوية وخاصة فى المعاملة بالزيوت المعدنية + NaHCO3 يليه زيت الثوم و NaHCO3، تم زيادة الوزن الجاف بشكل ملحوظ في المعاملة بـ NaHCO3 يليه زيت الثوم بالمقارنة بالكنترول المعامل بالماء فقط.تم دراسة تأثير بيكربونات الصوديوم والزيوت على الوزن الرطب والوزن الجاف للازهار وعلى ارتفاع النبات وذلك تحت ظروف العدوى الطبيعية من البياض الدقيقي في الحقل، وزادت بشكل ملحوظ هذه القياسات الماخوذة فى المعاملة بكل من NaHCO3+ الزيت المعدنى تليها NaHCO3الينسون ، وبعد المعاملة بـ ٤ و ٦ أسابيع كانت المعاملة NaHCO3+ الزيت المعدني سواء في الوزن الرطب اوالجاف يليه زيت الينسون.