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ORGANIC ACID POTENTIALS VERSUS FUNGICIDES INFLUENCE IN BARLEY POWDERY MILDEW CONTROL.

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ABSTRACT

Greenhouse and field experiments were carried out to evaluate the antifungal activity of propionic, formic and acetic acids, as well as two systemic fungicides; diniconazole (Sumi -8) and bromoconazole (Vectra), to control barley powdery mildew (*Blumeria graminis* f. sp. *hordei*). disease severity (%) was substantially reduced by 35% in maximum seedling (treatment), with organic acids, 24h before inoculation, while significant reduction in severity (62% to 81%) was found when these compounds, sprayed, 24 after inoculation. Fungicide application by the systemic fungicides under study (Sumi-8 and Vectra) completely controlled powdery mildew in barley seedlings, either before or after inoculation. The tested organic acids and fungicides, were able to suppress and restrict the rate of pathogen development, as shown by the long incubation and latent periods. Spraying barley seedlings, 24 after inoculation, significantly increased both incubation period (IP) and latent period (LP) over the control (untreated) treatment, under the inoculation conditions in the greenhouse .

Field application of organic acids and fungicides, tested at Giza and Gemmeiza resulted to large extent in effective powdery mildew control, expressed as a reduction in leaf area mildewed, restriction in area under disease progress curve and decreasing estimates of average coefficient of infection, compared to the untreated plants.

Single and twice application of the tested organic acids and fungicides, significantly improved yield components, except number of grains per spike. Twice application of Sumi-8 fungicide and propionic acid, were the most effective treatments, resulting in a significant increase in spike weight, spike length and 1000 kernel weight, relative to the untreated control. Lower response was obtained in barley plants, treated with formic and acetic acids as well as the fungicide; Vectra.

The total chlorophyll content in leaves was generally increased after spraying Sumi-8 (46.12%) and Vectra (64.87%) and to a less extent after single application of propionic (41.72%), formic (33.10%) and acetic acids (25.95%). Double spraying of the afore-mentioned organic acids comparatively increased the total chlorophyll content. Although the three organic acids in concern were relatively less effective in reducing PM disease in barley than the tested fungicides, they are considered environmentally less persistent and more safe for animal and human health. Therefore, these natural compounds can be effectively used in barley powdery mildew disease management programs especially at early stages of disease development.

INTRODUCTION

Powdery mildew of barley (*Hordeum vulgare* L.) incited by *Blumeria graminis* DC f.sp *hordei* Em. Marchal (syn. *Erysiphe graminis* DC f.sp *hordei* Em. Marchal), considered one of the most destructive diseases in many countries, including Egypt and Europe as well.

The loss was determined to exceed 20% in some barley cultivars (Johonsen, 1964). Moreover, it occurs regularly in Egypt, particularly in the northern parts of the Delta region of the nile, where humidity and temperature are favorable for both disease incidence and development. The early foliage infection, in February could significantly result in a yield reduction ranging from, (10 – 15%), in Egypt, where most of the exotic and local cultivars were scored susceptible and severely mildewed (Ghobrial *et al.,* 1977& 1983; Mostafa *et al.,* 1989 and Rizk *et al*., 1991).

Owing to the failure of almost all the commercial barley cultivars, to escape crop damage, until now, searching of effective means of powdery mildew control, should be necessary therefore, foliar application of certain recommended fungicides, is still the main commercially acceptable management practice to provide the high protection standards and consequently improving the grain yield even under adverse condititions in the field (Cunnigham and Dunne, 1976; Tusa *et al*., 1982; Ghobrial *et al*., 1983; Takano, 1986; Mercer and Mc Gimpsey, 1986; Rizk *et al*., 1991 and Conry and Dunne, 2001). The complete dependence on fungicides for disease control, however, is subject to a potential problems related to the phytotoxic side effects and adaptive tolerance, or acquired resistance to the pathogen against these synthetic for mulations especially, after greater application (Karadge and Karne, 1985 and Kaleeq and Klah, 1986). One alternative strategy for controlling powdery mildew of barley, that has not yet to be fully utilized in Egypt, is the use of some natural chemical compounds, as an environmentally safe and effective tool for the disease control.

The present work was, therefore, aimed to evaluate the antifungal activity and efficacy of the three organic acids; propionic, formic and acetic acids as well as the two recommended fungicides; Sumi-8 and Vectra in controlling powdery mildew of barley. In addition, to recognize the effect of these compounds on barley grain yield and quality, under severe disease stress in the field.

MATERIALS AND METHODS

1- Chemicals and formulations used

Propionic acid [cH_3 cH_2 cooH], formic acid [HcooH] and acetic acid [cH_3 cooH], as well as two fungicides; Sumi-8 [Dinoconazole] and Vectra [bromoconazole], were tested to evaluate their effectiveness against barley powdery mildew disease caused by *Blumeria graminis* f.sp. *hordei* [*Erysiphe graminis* f.sp. *hordei*]

2. Greenhouse experiments:

Grains of Giza 123 barley cv. obtained from Barley Research Section, ARC, were sown in 5-inch clay pots in three replicates. Seedlings (8-days old) were artificially inoculated with a mixture of freshly collected conidiospors of the most dominant races of *Blumeria grominis* f. sp. *hordei,* under greenhouse conditions (18-22^{o}C) (Nair and Ellingba 1962). Twenty four hours after inoculation, leaves, were sprayed with the chemicals and fungicides in concern. Check plants were sprayed with the distilled water. The experiment was carried out in completely randomized block design with 3 replicates/treatment.

Table (1): Trade name, chemical composition and used concentration for the organic chemicals and fungicides used.

Names	Chemical composition	Used concentration
Propionic acids (proponoic acid)	cH_3 cH_2 cooH	1 ml/litre water
Formic (methanoic acid)	HcooH	1 ml/litre water
Acetic acid (ethanoic acid)	cH_3 cooH	1 ml/litre water
Fungicides: Sumi-8	Dinoconazole	35 ml/100 litre water
Vectra	Bromoconazole	100ml/100litre water

Disease assessment at seedling stage:

a-Infection type (IT):

Eight days after the treatment with the tested chemicals and fungicides, a powdery mildew disease was assessed as IT using 0-4 a scale:

0: Highly resistant (HR); no visible sings of infection
1: Resistant (R); a slight development of mycelium.
2: Moderately resistant (MR); moderate to abundant development of mycelium with slight production of conidia
3: Moderately susceptible (MS); moderate to abundant development of mycelium accompanied by moderate sporulation.
4: Susceptible (S); large pustules, abundant sporuation.

Plants with 0,1 and 2 IT were classified as resistant, whereas those showing 3 and 4 IT were classified as susceptible plants.

b. Disease severity (%):

The percentage of disease severity was calculated using by following equation, developed by Towsend and Heuberger (1943):

$$P = (\Sigma (n \times v) /(4n))\times 100$$

Where: P= Disease severity (%)
n = Number of leaves within infection grade.
v = Value of each grade
n = Total number of samples.

C. Incubation period (IP):

Incubation period (IP) was estimated as the number of days between inoculation and the first appearance of disease symptoms i.e. flecks (Holliday, 1989).

d. Latent period (LP_{50}):

Latent period is the time (days) from the day of inoculation to the day when 50% of the pustules had erupted and ruptured the epidermis of plant leaves (Andrres, 1982).

2. Field experiments:

Field evaluation of the mature barley plants was carried out under natural infection at two locations; Giza and Gemmeiza Experiment stations, during 2006/2007 growing season.

The experiment was conducted in a randomized complete block design (RCBD), with three replicates. The plot size was 3 x 3.5 m^2 (1/400 feddan), each plot included 6 rows with 3m. long and 30 cm. apart. Different treatments were first carried out at the beginning of mildew lesions appearance. The second group spray for the same time, then other sprays after 15 days intervals, while the control plots were sprayed with plain water.

Disease assessment, under field conditions:

The reaction of barley plants to powdery mildew was recorded at growth stage; 10.5 (Large, 1954), according to double-digit scale oo-99.

The first digit gives the relative height of the disease, while the second digit shows the disease severity as a percentage of leaf area effected in terms of 0-9, where: 0 = 0%, 2 = 20%, 3=30% and soon (Eyal *et al.* 1987).

***Average coefficient of infection (ACI):**

Coefficient of infection (CI) of powdery mildew were calculated by multiplying the response value (Table 2) with the severity of infection in percent, according to CIMMYT and IRN, international Rust Nurseries. Akhtar *et al.* (2002)

Average coefficient of infection (ACI) was derived from the sum of CI values of each treatment, divided by the number of replicates.

Table (2): The observation and response of barley plants to powdery mildew infection at adult stage:

Reaction		Observation	Response value
1	No disease	HR	0.0
2	Resistant	R	0.1
3	Resistant – Moderately resistance	R-MR	0.2
4	Moderately resistant	MR	0.3
5	Mod. Res- Mod. Susc.	MR-MS	0.4
6	Moderately susceptible	MS	0.6
7	Mod. Susc – Suscep.	MS-S	0.8
8	Susceptible	S	0.9
9	Highly susceptible		1.0

*** Area under disease progress curve (AUDPC):**

The (AUDPC) was calculated using a simple formula adopted by Pandey *et al.,* (1989) as follows:

$$AUDPC = D\,[(1/2\,(y_1 + y_k) + (y_2 + y_3 + \ldots\ldots + y_{k-1})]$$

Where: $Y_1, Y_2 \ldots\ldots, Y_k$ = disease observations; disease severity (%), at a constant interval between the scores D days.

Reduction (%) in powdery mildew infection less than the control treatment was calculated according to the formula described by Evans *et al.,* (1973), as follow:

Reduction (%) $= [(D_2 - D_1)/D_2] \times 100$

Where: D_1 = disease assessment on treated plants.
D_2 = " " on untreated (control) plants.

***Estimate the amount of chlorophyll content in barley plants:**

The amount of chlorophyll, was measured using portable chlorophyll meter (SPAD-502, Minotta, Japan), developed by the soil and plant Analysis Department unit of Minolta Camera Company. A chlorophyll meter (Minolta SPAD- 502) has been used for associating the relative chlorophyll content of barley leaves with the one-dimensional values established by the meter (green color intensity index). This meter takes instant reading without having to destroy the plant tissue. Samples and the reading are performed in a very short time (2s). Also, the use of this meter saves time, space and resources. The readings obtained by the meter refer to the quantification of light intensity (650 mm) absorbed by the tissue sample (Wood *et al.,*1993 and Markwell *et al.,* 1995).

However, chlorophyll content was determined as SPAD unit, these units were transformed to mg/m^{-2} as described by Monje and Bugbee (1992) as followes:

Chlorophyll content (mg-/m^{-2}) = 80.05+10.4[SPAD 502].

Where: SPAD 502= chlorophyll meter Reading (CMR).

Yield components:

Barley plants were harvested 165 days after sowing and the following yield components were determined:

1- spike weight (gm)
2- Number of grains per spike.
3- Length of spike (cm).
4- Weight of thousand grains (gm.)

The increase (%) = [$Y_t – Y_c/Y_c$] x 100

Where: Y_t = Yield component value of the treated plant
Y_C = " " " untreated control plants

All data were statistically analyzed using the analysis of variance method described by Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Results

Three organic acids; propionic, formic and acetic, as well as two systemic fungicides; Sumi-8 and Vectra, were evaluated for in controlling and suppressing barley powdery mildew disease caused by *Blumeria graminis* f.sp. *hordei* The effectiveness of these compounds was estimated under both greenhouse and field conditions.

A Greenhouse studies:):

Data presented in Table (3) show that foliar spray, of the three organic acids; 24h before inoculation resulted in limited or relatively low effect in reducing powdery mildew infection. The disease severity ranged from 55% to 80%, compared to 85% for the control treatment.

Meanwhile, foliar spray 24h after inoculation caused significant reduction in the disease severity. Application of propionic acid at the used concentration showed, however, the highest efficiency in reducing disease severity (82.35%), followed by the formic acid (76.47%), while foliar spray of acetic acid revealed the lowest efficacy in reducing disease severity (64.71%). In addition, the application of the two systemic fungicides under study; Sumi-8 and Vectra as a foliar spray either before or after inoculation completely controlled powdery mildew in barley plants (Table, 3). No disease was recorded with the application of Sumi-8 Vectra at the used concentrations either before or after inoculation treatment.

Table (3): Effect of spraying barley seedlings (Cv., Giza 123) with the tested organic acids and fungicides before and after inculation with *Bluneria graminis* f. sp. *hordeie* on disease severity % under greenhouse conditions.

Chemical compounds	Concentration	Disease severity (%)			
		Before inoculation	Reduction (%)	After inoculation	Reduction (%)
Propionic acid	1 ml/litre water	55	35.29	15	82.35
Formic acid	1 ml/litre water	75	11.76	20	76.47
Acetic acid	1 ml/litre water	80	5.88	30	64.71
Sumi-8	0.35 ml/100 litre water	0.0	100	0.0	100
Vectra	1 ml/100litre water	0.0	100	0.0	100
Control	-	85	-	85	0
L.S.D at 5%		13.99	-	23.09	0

*reduction (%): relative to the control (untreated) plants.
** Control : untreated and infected plants.

On the other hand, barley powdery mildew infection, expressed as incubation period (IP) and latent period (LP) were differentially affected after spraying the primary leaves of barley seedling (Cv.; Giza 123) with the tested compounds. Wherein, the application of these chemical compounds 24h after inoculation resulted in prolonging and / or increasing the length of both incubation and latent periods in the treated plants, relative to the control. The highest significant increase in incubation period was obtained by spraying the systemic fungicides; Sumi-8 (43.40%) and Vectra (42.94%), and the application of propionic acid (41.95%) as well. The relatively low effect in incubation period (IP) was obtained by the application of formic acid (22.785) and acetic acid (18.91) %.

Likewise, the time in days between inoculation and that required to get 50% pf erupted pustules (LP), was longer when the tested compounds were used (Table, 4). The best effect was obtained following application of Sumi-8 and Vectra, followed directly by the use of propionic being acid. 40.0%, 37.33% and 36.40% respectively, found in the length of latent periods (LP) after the application of the use of other acids under study; formic acid and acetic acid, showed the lowest effect in this regard and the increment in LP did not exceed did not exceed 12.12% and 9.09% (Table, 4).

Table (4) Effect of spraying barley seedlings (Cv., Giza 123) with different organic compound and fungicides on inoculation and latent periods (day) of *Bluneria graminis* f.sp. *hordei* , at seedling stage under greenhouse conditions.

Chemical compounds	Concentration	Powdery mildew resistant compnents			
		Incubation period (day)	Increase (%)	latent periods (day)	Reduction (%)Increase (%)
Propionic acid	1 ml/litre water	9.75	41.95	11.25	36.36
Formic acid	1 ml/litre water	7.23	22.78	9.25	12.12
Acetic acid	1 ml/litre water	6.98	18.91	9.00	9.09
Sumi-8	0.35 ml/100 litre water	10.00	43.40	11.55	40.00
Vectra	1 ml/100litre water	9.92	42.94	11.33	37.33
Control	-	5.66	-	8.25	-
L.S.D at 5%		0.97		1.18	

* Control : untreated and inoculated barley seedlings.

**increase (%): the percentage of an increase relative to the control.

B. Field studies:

The efficacy of fungicides and organic acids under study for controlling barley powdery mildew infection was estimated in field trials at the two different growing conditions; in Upper Egypt and Delta of the Nile at Giza and Gemmeiza locations respectively.

Barley powdery mildew infection, expressed as a percentage of leaf area mildewed, (PM disease severity %), area under disease progress curve (AUDPC) and average coefficient of infection (ACI) as effected by the application of foliar spraying of the tested compounds, was estimated and the results obtained in Tables (5 and 6) the results in general summarizing the fact that the two fungicides as well as the three organic acids effectively controlled PM disease in Giza 123 plants, when each applied as two sprays rather than one spray treatment

PM disease severity (%):

The results indicated, that powdery mildew severity, was significantly decresed (at p = 0.05) on barley plant of the susceptible cv.; Giza 123, treated with the two systemic fungicides and the three organic acids used. It was noticed in general that the percentage of disease severity was relatively lower at Giza environmental conditions than at Gemmeiza conditions, during the growing season of the study.

The highest decrease in PM severity (up to 90%) was obtained by using the to two systemic fungicides; Sumi-8 and Vectra, especially when sprayed twice. On the other hand, sprayed treatments with the three organic acids used (either one or two sprays), resulted in relatively higher PM severity (%) compared to those sprayed with the two fungicides, but they still significantly lower than unsprayed checks. However, he obtained results showed that propionic acid was the most effective organic compound (67.97% and 72.19%); came directly after the two systemic fungicides tested followed by acetic acid (06.0% and 41.66%) and formic acid (25% and 29.16%) twice at EL-Giza and EL-Gemmeiza.

Average coefficient of infection (ACI):

Foliar spray of barley plants cv.; Giza 123 with the five compounds, resulted in a significant reduction in ACI, especially when applied twice (Tables, 5 and 6). The highest reduction (up to 97%) in ACI, compared to the untreated control, was obtained by the twice application with the two systemic fungicides; Sumi-8 and Vectra, at both location of the study. This reduction reached only (90.95% - 90.78%), (758.38% - 72.59%) and (78.61% - 86.56%), propionic, formic and acetic acids, were sprayed at Giza and Gemmeiza localities, respectively (Tables,5 and 6)

Table (5): Effect of spraying barley plants (Cv., Giza 123) with the tested organic acids and fungicides (single and booster application) on disease severity (%), average coefficient of infection (ACI) and area under disease progress curve (AUDPC) of *Blumeria grominis* f.sp. *hordei* under El-Giza Res. Stat. during 2006/2007 growing season.

Treatments & concentrations	Powdery mildew								Disease parameters						
	Disease severity (%)			Reduction (%)		ACI			Reduction (%)		AUDPC			Reduction (%)	
	S.A.*	B.A.**	Mean	S.A.	B.A.	S.A.	B.A.	Mean	S.A.	B.A.	S.A.	B.A.	Mean	S.A.	B.A.
Propionic acid 1 ml/litre water	36.00	21.67	28.84	53.05	67.97	16.67	5.50	11.09	72.8	91.10	376.80	123.08	249.94	71.24	90.95
Formic acid 1 ml/litre water	63.33	60.00	61.67	17.40	25.00	38.00	25.00	31.50	51.61	59.24	455.58	322.58	389.08	66.51	75.38
Acetic acid 1 ml/litre water	63.33	26.67	45.00	17.40	60.00	28.35	16.67	22.51	54.27	72.80	423.70	280.25	351.98	68.85	78.61
Sumi-8 0.35 ml/100 litre water	13.33	3.33	8.33	82.61	95.00	3.50	1.67	2.59	94.30	98.90	88.08	20.42	54.25	93.28	98.50
Vectra 1 ml/100litre water	16.67	4.33	10.50	78.26	93.51	3.83	1.67	2.75	93.80	98.90	93.92	23.33	58.63	92.83	98.29
Control (untreated)	76.67	66.67	71.67	-	-	62.0	61.33	61.67	-	-	1360.33	1310.17	1335.25	-	-
Mean	44.89	30.45				25.39	18.64				466.40	346.64			
L.S.D. at (0.05)	Treatment (T) = 6.65					(T) = 4.20					(T) = 84.94				
	Application (A) = 2.07					(A) = 2.42					(A) = 49.04				
	Interaction (T x A) = 9.40					(T x A) = 5.94					(T x A) = 120.12				

*S.A. = Single application.
** B.A.= Booster application.
ACI = Average coefficient of infection
AUDPC = Area under disease progress curve.

Table (6) Effect of spraying barley plants (Cv., Giza 123) with the different organic compounds and fungicides as a (single and booster application) on disease severity (%), average coefficient of infection (ACI) and area under disease progress curve (AUDP) of *Blumeria grominis* f.sp. *hordei* under El-Gemmeiza Res. Stat. during 2006/2007 growing season.

Treatments & concentrations	Disease severity (%)			Reduction (%)		ACI			Reduction (%)		AUDPC			Reduction (%)	
	S.A.	B.A.	Mean	S.A.	B.A.	S.A.	B.A.	Mean	S.A.	B.A.	S.A.	B.A.	Mean	S.A.	B.A.
Propionic acid 1 ml/litre water	60.0	21.67	40.84	30.77	72.91	19.67	8.66	14.17	71.17	89.17	415.33	141.25	278.29	72.51	90.78
Formic acid 1 ml/litre water	70.0	56.67	63.34	19.23	29.16	38.00	23.00	30.00	45.19	71.25	856.83	420.08	638.46	43.29	72.59
Acetic acid 1 ml/litre water	63.33	64.67	55.00	26.93	41.66	25.33	18.67	22.00	63.46	76.66	541.67	205.92	373.80	64.15	86.56
Sumi-8 0.35 ml/100 litre water	21.67	4.33	13.00	75.00	94.59	5.51	1.30	3.41	92.05	98.38	86.42	36.17	61.29	94.28	97.64
Vectra 1 ml/100litre water	26.67	5.00	15.84	69.23	93.75	6.67	1.67	4.17	90.38	97.91	118.92	55.33	87.13	92.13	96.39
Control (untreated)	86.69	80.00	83.34			69.33	80.00	88.17			1511.00	1532.61	1521.81	-	-
Mean	54.72	35.72				27.42	22.22				588.36	398.56			
L.S.D. at (0.05)	Treatment (T) = 8.86					(T) = 4.97					(T) = 77.36				
	Application (A) = 2.08					(A) = 2.87					(A) = 44.66				
	Interaction (T x A) = 12.53					(T x A) = 7.03					(T x A) = 109.402				

*S.A. = Single application.
** B.A.= Booster application.
ACI = Average coefficient of infection
AUDPC = Area under disease progress curve

Area under disease progress curve (AUDPC):

The compounds under investigation apparently reduced the AUDPC for the treated barley plants, especially when sprayed twice. The highest treatment for reducing the AUDPC was obtained by twice application with the two systemic fungicides, Sumi-8 (98.50% - 97.64%) and Vectra (98.29% - 96.39%), followed by propionic acid (90.78% and 90.95%) at Giza and Gemmeiza, respectively (Tables; 5and 6).

Meanwhile, low protection was obtained by the application of the other two organic compounds; formic and acetic acids, in both locations. Whereas the estimated reduction (%) of AUDPC, reached

(75.38% - 72.59%) and (78.61 – 86.56%) with the application of the formic acid and acetic aced respectively, under field conditions at the two locations, (Tables; 5 and 6).

Yield components:

Spraying barley plants of; Giza 123 cv. with the three tested chemical either organic acids or systemic fungicides increased grain yield components over the unsprayed control in both locations (Tables, 7 and 8). The twice applications with each of the tested compounds resulted in a significant increase in most yield components except number of grains/spike. The highest effects was obtained, however on the spike weight (gm), spike length (cm) and 1000 kernel weight (gm). When the propionic acid was applied twice, followed by Sumi-8. The application of formic and acetic acids as well as the fungicide, Vectra, resulted in the lower increase (%) in the above mentioned components of barley plants (Table, 1 and 8).It could be concluded that

Table (7) Effect of spraying barley leaves (Cv., Giza 123) with the tested organic acids and fungicides (as single and booster application) on for yield components under field conditions at Giza Res. Stat. during 2006/2007 growing season.

Treatments & concentrations	Yield components																			
	Spike weight (g.)			Increase (%)		No. of grains/spike			Increase (%)		Spike length (cm)			Increase (%)		100 kernel weight (g.)			Increase (%)	
	S.A.*	B.A.**	Mean	S.A.	B.A.	S.A.	B.A.	Mean	S.A.	B.A.	S.A.	B.A.	Mean	S.A.	B.A.	S.A.	B.A.	Mean	S.A.	B.A.
Propionic acid 1 ml/litre water	4.11	4.51	4.31	25.69	37.50	60.13	62.10	61.12	10.53	9.72	10.29	11.37	10.83	20.07	28.77	55.80	59.31	57.56	17.65	24.05
Formic acid 1 ml/litre water	3.69	3.97	3.83	12.84	21.04	57.73	59.59	58.6	6.12	5.28	9.17	9.67	9.42	7.00	9.51	50.81	51.26	51.04	7.13	7.22
Acetic acid 1 ml/litre water	3.82	4.22	4.02	23.24	29.05	58.13	61.10	59.62	6.86	7.95	10.06	10.54	10.30	17.39	19.32	58.11	58.32	55.72	11.98	21.98
Sumi-8 0.35 ml/100 litre water	4.07	4.35	4.21	24.47	33.84	59.13	60.33	59.73	8.70	6.59	10.24	10.67	10.46	19.49	20.84	51.22	52.73	51.98	7.99	10.29
Vectra 1 ml/100litre water	4.03	4.20	4.12	16.82	28.66	55.33	57.80	56.57	1.71	2.12	9.57	10.90	9.84	11.67	14.43	48.96	49.54	49.25	3.23	3.62
Control (untreated)	3.27	3.28	3.28	-		54.40	56.60	55.50	-	-	8.57	8.83	8.70	-	-	47.43	47.81	47.62	-	-
Mean	3.83	4.09				57.48	59.59				9.65	10.20				51.22	53.16			
L.S.D. at (0.05)	Treatment (T) = 0.41					(T) = 3.23					(T) = 0.4					(T) = 2.43				
	Application (A) = 0.24					(A) = 1.86					(A) = 0.27					(A) = 1.4				
	Interaction (T x A) = NS					(T x A) = NS					(T x A) = NS					(T x A) = NS				

*S.A. = Single application.

** B.A.= Booster application.

The spike weight at Giza location was significantly increased (Table 7) over control by the twice application of propionic acid (37.50%), followed by Sumi-8 (33.84%), acetic acid (29.05% and Vectra (28.66%). Meanwhile, the lowest increase (21.05%) was obtained by the twice application of formic acid. Moreover, the booster application of propionic acid, led to the highest increase in both spike length and 1000 kernel weight (28.77 and 24.05% respectively), followed by Sumi-eight (20.84% and 21.98%, respectively). The other compounds; either the systemic; Vectra fungicide or the two organic acids; acetic and formic were less effective in increasing both spike length and 1000 kernel weight when each used as a single or booster application. The increase in spike length and kernel weight, the twice application of acetic acid Vectra and formic acid (19.32% and 10.29), (14.43 and 3.62) and (9.51% and 7.22%), respectively.

Data obtained under El-Gemmeiza environment conditions (Table 8) were similar to those recorded at El-Giza location. The application of the tested compounds as a foliar spray significantly increased the grain yield components over the control, except number of grains/spike. The highest effect was obtained when this compound were applied as two foliar sprays or as booster application. In general, the increase in spike weight (gm), was obtained, when propionic acid (29.76%), Sumi-8, (22.26%) formic acid (19.05%), acetic acid (19.05%) and Vectra (18.75%), were used as a booster application, regarding the spike length and 1000 kernel weight the best effect was recorded for propionic acid when applied twice as a foliar spray in the field, followed directly by Sumi-8 and acetic acid. However booster application of the three chemicals mentioned above resulted in on increase over the control by (22.65% and 16.78%), (15.18% and 15.62%) and (13.25% and 14.75%) in spike length (cm) and 1000 kernel weight (g), respectively.

Vectra and formic acid, on the other hand, resulted in the lowest effect in this concern (Table, 8). However, either single or booster application of these compounds, led to a lesser increase (%) over the control in both spike length and 1000 kernel weight, compared to the other chemicals under study.

Table (8) Effect of spraying barley leaves (Cv., Giza 123) with the tested organic acids and fungicides (as single and booster application) on for yield components under field conditions at El-Gemmeiza Res. Stat. during 2006/2007 growing season.

Treatments & concentrations	Yield components																			
	Spike weight (g.)			Increase (%)		No. of grains/spike			Increase (%)		Spike length (cm)			Increase (%)		100 kernel weight (g.)			Increase (%)	
	S.A.*	B.A.**	Mean	S.A.	B.A.	S.A.	B.A.	Mean	S.A.	B.A.	S.A.	B.A.	Mean	S.A.	B.A.	S.A.	B.A.	Mean	S.A.	B.A.
Propionic acid 1 ml/litre water	4.01	4.36	4.19	22.26	29.76	62.90	63.67	63.29	6.02	6.70	9.90	10.83	10.37	15.52	22.65	55.25	58.68	56.97	11.62	16.78
Formic acid 1 ml/litre water	3.79	4.00	3.90	15.55	19.05	60.62	62.11	61.37	2.17	4.09	9.20	9.80	9.50	7.35	10.99	52.68	53.58	53.13	6.42	6.63
Acetic acid 1 ml/litre water	3.69	4.00	3.85	12.50	19.05	60.67	61.61	61.14	2.26	3.25	9.40	10.0	9.70	9.69	13.25	55.07	57.66	56.37	11.25	14.75
Sumi-8 0.35 ml/100 litre water	3.85	4.01	3.93	17.38	22.26	62.33	63.53	62.93	5.06	6.47	9.45	10.17	9.81	10.27	15.18	55.18	58.10	56.64	11.48	15.62
Vectra 1 ml/100litre water	3.69	3.99	3.84	12.50	18.75	61.57	62.57	62.07	3.78	4.86	9.15	9.7	9.43	6.77	9.85	52.50	54.25	53.38	6.06	7.96
Control (untreated)	3.28	3.36	3.32	-	-	59.33	59.67	59.50	-	-	8.57	8.83	8.70	-	-	49.50	50.25	49.88	-	-
Mean	3.72	3.95				61.24	62.19				9.28	9.89				53.36	55.42			
L.S.D. at (0.05)	Treatment (T) = 0.28					(T) = 3.99					(T) = 0.92					(T) = 2.44				
	Application (A) = 0.16					(A) = NS					(A) = 0.53					(A) = 1.41				
	Interaction (T x A) = NS					(T x A) = NS					(T x A) = NS					(T x A) = NS				

*S.A. = Single application.
** B.A.= Booster application.

Chlorophyll content:

The effect of single and twice field application of the tested organic acids and fungicides, on total chlorophyll content of barely leaves, cv.; Giza 113, were studied and the obtained data were presented in Table (9). Data in Table (9) showed that spraying barley plants with organic acids and /or fungicides (either single or booster application); significantly increased chlorophyll content in compared with untreated ones. Furthermore, this increase was much higher in booster application compared with single application. However, due to the non significant of interaction between treatment (T) and application method (A), L.S.D. was used to compare between grand mean of T and grand mean of A.

Although, all treatments increased chlorophyll content in the treated barley plants, significant variation was found between the treatments, under study. However, propionic acid as well as the fungicide treatments; Sumi-Eight and Vectra were most effective. They recorded maximum increase in total chlorophyll content of barley leaves; 49.79%, 46.12% and 41.72% increase over the control, respectively, when sprayed as a single application. Meanwhile, this increase reached 64.87%, 58.44% and 53.70%, respectively, when applied as a booster application (Table, 9).

Moreover, formic acid was also effective in increasing the total chlorophyll content, either as a single (33.10%) or booster application (41.77%). Acetic acid was the least effective treatment, which showed

Table (9) Effect of spraying barley plants (Cv., Giza 123) with the tested organic acids and fungicides (as single or booster application) on leafs chlorophyll content (mg/m^{-2}) under field conditions.

Chemical compound & concentrations	Single application			Booster application			Mean	
	SAAD-CMR (502)	Amount of chlorophyll (mg/m^{-2})	Increase (%)	SAAD-CMR (502)	Amount of chlorophyll (mg/m^{-2})	Increase (%)	SAAD-CMR (502)	Amount of chlorophyll (mg/m^{-2})
Propionic acid 1 ml/litre water	42.18	518.72	49.79	47.20	570.93	64.87	44.69	544.83
Formic acid 1 ml/litre water	36.62	460.90	33.10	39.44	490.23	41.77	38.03	475.57
Acetic acid 1 ml/litre water	34.24	436.15	23.95	36.19	456.43	31.81	35.22	446.29
Sumi-8 0.35 ml/100 litre water	41.00	506.45	46.12	45.06	548.67	58.44	43.03	527.56
Vectra 1 ml/100litre water	39.49	490.75	41.72	43.48	532.24	53.70	41.49	211.50
Control (untreated)	25.60	346.29	-	25.60	346.29		25.60	346.29
Mean	36.52	459.88		39.50	490.80		38.01	475.34
L.S.D. at (0.05)	Treatment (compounds) T = 3.04, application (A)= 1.75 and interaction (T x A)= NS							

*SPAD = chlorophyll meter Reading (CMR)

** Increase (%) = the percentage of increase over the control treatment

23.95% increase in total chlorophyll content, when sprayed as a single treatment. But it recorded 31.81% increase when sprayed as a booster application (Table, 9).

Discussion

Releasing and utilization of resistant varieties as well as the application of specific fungicides are traditionally still the most effective methods for controlling powdery mildew disease of barley. Meanwhile, the presence and development of a high number of powdery mildew races, were found to pose an important problem in breeding and producing the new resistant barley varieties. Furthermore, the routine and wide application of the synthetic fungicides, developed resistant or tolerant races to these chemicals and consequently decreased their fungicidal potentiality or effectiveness. (Kuc, 1991, (Ghobrial *et al.*1983 and Rizk *et al.,*1991). The harmful side effects of the widely used fungicides on environment and human health, promoted this investigation in search of an alternative and more safe method of disease control. In the present investigation spraying organic acids for controlling barley PM was compound with traditional systemic PM fungicides barley seedling (cv.; Giza 123) under favorable greenhouse condition. The propionic acid, when used as a foliar spry (1 ml/ L. water) was the most effective in disease control of the followed by formic acid, while acetic acid. At the same concentration showed the lowest effect.

Although, all the tested organic acids, clearly, minimized the mildewed area with varying degrees, of (disease severity %), prolonged both incubation and latent periods which are considered the main components of partial resistance (Wilson, 1994), these chemicals did not have the ability to alter infection type (IT) from susceptible to resistant type. It may be, therefore, suggested that the application of the aforementioned organic acids possibly provide a curative action for controlling PM disease, and in the same time, it may enhance partial resistant not complete resistance in barley seedlings (Hammouda *et al.,* 2001).

Regarding the foliar spray of of Sumi-eight (Diniconazole) and Vectra (bromoconazole), which are among the systemic fungicides, under greenhouse conditions. either before or after inoculation, it is shown that the disease was completely checked compared to the untreated and artificially inoculated seedling. These results are in accordance with those of Takano, (1986) and Pancaldi *et al.* (1988) who mentioned that, diniconazole proved to have a broad spectrum fungicidal activity against pathogens of cereals, grapevine, apple and groundnut. They added that the mode of action of this new triazole fungicide is as an inhibitor of 14 alpha-demethylation in ergosterol biosynthesis.

Field spray of barley, either single or twice, at the two locations have shown, frequent reduction in the amount of powdery mildew disease on Giza 123 variety. Analysis of the obtained data over the two locations, proved in general that the use of different chemicals resulted in a significant reduction in disease severity (%), area under disease progress curve (AUDPC) and average coefficient of infection (ACI) compared to the control treatment. The highest reduction in the aforementioned three epidemiological parameters, were recorded with the application of propionic acid, as well as Sumi-eight and Vectra. Meanwhile, the lowest disease protection was obtained by the application of the other tested organic acids; formic and acetic acids, as they showed the lowest effect in, either one or double spray applications. Double Spraying, at two weeks interval of other chemicals under investigator, significantly reduced the former three disease parameters much more than one spray application.

Although, propionic, formic and acetic acids, proved to be less effective in controlling PM disease than the two fungicides under study, they are less persistent, thus being environmentally more safe than the synthetic fungicides as well. Furthermore, the routine and wide application of these fungicides may leave chemical residues in soil, water and grains (Singh *et al.,* 1994) and subsequently may affects animal and human health (Kuc, 1991).

Control of powdery mildew in this work was accompanied by a sufficient increase in the grain yield components of the treated barley plants (cv. Giza 123), except number of grains per spike, where there was a direct relationship between the disease infection and yield (Cunninham and Dunne, 1976, Tusa *et al.,* 1982 and Conry and Dunne, 2001).However twice application, of Sumi-eight and propionic acid led to a significant and high increase in spike weight, spike length and 1000 kernel weight. In contrast, smaller yield response was obtained by using the other two organic acids (formic and acetic) as well as the systemic fungicide; Vectra. Similar results were previously obtained by Tusa *et al.,* (1982) who reported that the application of the tested fungicides, significantly reduced powdery mildew and leaf rust infections in barley plants, and consequently increased grain yield by 2 – 10%. Moreover, a significant reduction in Pm disease severity (%) was obtained and a yield increase (0.5 t/ha) was achieved with either carbonizing or propiconazole application in controlling barley PM disease (Mercer and MC Gimpsey, 1986). Yield responses to fungicide treatment and its magnitude were directly related to the mildew susceptibility of the tested cultivar. Hence the use of fungicide improved the yield of susceptible, more than that of the cultivars with medium or high resistance. In Addition, the happened increase being greater at higher levels of nitrogen Fertilization Tusa *et al,* (1982). Mean while, Conry and Dunne (2001), stated that the application of a broad, spectrum fungicide; Punch, reduced powdery mildew infection and improved grain yield, but the magnitude of yield response depended on disease severity. Furthermore Cunnigham and Dunne (1976), evaluated grain yield reponses to systemic fungicide application and came to the conclusion that fungicidal control of a disease largely improved grain yield, because it increased the useful life span of the green leaf which resulted in better filled grains. The same conclusion was reached by Ghobrial *et al.* (1983) in Egypt who found that 20 -30% of yield losses could be avoided by the use and application of specific chemicals.

Furthermore, some natural compounds including acetic aid and salicylic acid proved to be effective in suppression of powdery mildew fungi; *Sphaerotheca Fusca* and *uncirula nector* in field trials, resulting in interesting levels of protection against PM disease on table-grape (Casulli *et al.,* 2002). Meanwhile organic acids; glycolic, acetic, formic, n-butyric and propionic acids, which were detected by Abbasi *et al.* (2008) in fish emulsion (FE), were toxic to some plant pathogens and might have a role in disease suppression. Also, these organic compounds reduced the viability of *V. dahliae* microsclortia and were toxic to *Pythium ultimum* and provide immediate protection of cucumber seedling from damping off in an infested soil.

Acetic acid proved to be an excellent biocide against some fungal pathogens. it the acetic acid vapors are used as antifungal agents for controlling storage mould of canola, corn, rice and wheat grains (Sholberg and Gaunce, 1996 and Morsy *et al.,* 2000). Also, it was more effective for controlling and preventing post harvest decay of some fruits and vegetables (Sholberg *et al.,* 1998 and Morsy *et al.,* 1999). However, the inhibitory effect of this organic acid, on microorganisms is greater than that due to PH alone, and undissociated acetic acid as it can penetrate the microbial cell to exert its toxic effect (Banwqrt, 1981). Also, the mode of acetic acid action to inhibit microorganisms, is apparently, due to, its capacity to effect the cell membrane interfering with the transport of metabolites and maintenance of membrane potential (Sholberg *et al.,* 1998).

The total amount of chlorophyll content was significantly increased following the different treatments with the tested chemical, but the alteration in this content was much higher in booster application of ech tested compound than that in single one. The obtained results also revealed that an organic compound; propionic acid proved to be the most effective compound in this respect, followed by formic acid, while acetic was the least effective one. Moreover, fungicidal treatments; either with Sumi-8 or Vectra were superior as they resulted in a maximum increase in total chlorophyll content this increment my be due to stimulating pigment formation, enhancing the efficacy of photosynthetic apparatus and decrease in photo phosphorylation rate that usually occur after infection, with a better potential for disease resistance (Amaresh and Bhatt, 1988). Moreover, the application of some natural chemical products were found to increase potassium content, which may increase the number of chloroplasts per cell Possingham (1980), and /or activated the synthesis of carotenoids which protect chlorophyll from oxidation Farouk *et al.,* (1986) and finally decreased ethylene production (Leslie and Romani, 1986). All of these, lead to an increase in chlorophyll content and accelerated dry matter accumulation, and finally resulted in better filled grains.

Likely to mention that the happened increase in the level of chlorophyll contents of the treated barley plant accompanied by a substantial reduction in PM infection, compared with untreated-inoculated plants, under the same filed conditions. Hence, this may explain somewhat, the possible role of the tested chemicals in suppressing such disease and, consequently improved the grain yield. However, the disease reduction assumed to be due to the alteration in certain metabolic process and /or enhancement of some biochemical changes that may be considered as defense mechanisms in barley plants to PM pathogen attack or infection.

Although the tested fungicides, Sumi-eight and Vectra were more effective in reducing and suppressing PM disease in barely plants (Cv., Giza 123) than the three organic acids used they are considered environmentally safe and less persistent. Therefore, these natural organic acids can be effectively used as an alternative, safeguard compounds in barley powdery mildew disease management.

REFERENCES

Abbasi, P.A.; G. Lazarovits and Jabaji- Hare, S. (2008). Detection of high concentrations of organic acids in fish emulsion and their role in pathogen or disease suppression. Phytopathelogy. 99: 274 – 281.

Akhtar, M.A.; I. Ahamad; J.I. Mirza; A.R. Rattu; E.U.I. Haque; A.A. Hakro and A.H. Jasfery (2002). Evaluation of candidate lines against tripe and leaf rusts under national uniformed. Wheat and Barley yield Trial 2000 – 201.

Amaresh, C. and Bhatt, R.K. (1988). Biochemical and Physiological response to salicylic acid in reaction to systemic acquired resistance. Photosynthetica, 35(2): 255-258.

Andrres, M.W. (1982). Latent period and slow rusting in the *Hordeum vulgare* L. *Puccinia hordei* Otth host-parasite system. Ph. D. Thesis. University of Minnesota. St. Poul., USA. 113 pp.

Banwart, G.J. (1981). Basic Food Microbiology. AVI, Westport Conn. (C.f. Sholberg and Gaunce, (1995).

Carver, T.L.W.; R.J. Zeyen; W.R. Bushnell and Robbins, M.P. (1994). Inhibition of phenylalanine ammonia lyase and cinnamyl alcohol dehydrogenase increases quantitative susceptibility of barley to powdery mildew (*Erysiphe graminis* D.C.). Physiological and Molecular plant Pathology; 44 (4): 261 – 272.

Carver, T.L.W.; R.J. Zeyen and Lyngkiaer, M.F. (1995). Plant cell defences to powdery mildew of Gramineae. Aspects of Applied Biology; 42: 257-266.

Casulli, F.; A. Santomauro; G. Tauro; M.A. Gatto and Faretra, F. (2002). Effectiveness of natural compounds in the suppression of the powdery mildew fungi; *Sphaerotheca fusca* and *Uncinula nectar*. Bulletin, OILB/SROP; 25 (10): 179 – 182.

Conry, M.J. And Dunne, B. (2001). Influence of number and timing of fungicide applications on the yield and quality of early and latersown spring malting barley grown in the south. East of Ireland. Journal of Agriculture Science; 136 (2): 159- 167.

Cunnigham, P.C. and Dunne, B. (1976). Systemic fungicides reduce disease and increase yield of spring cereals. Farm and Food Research; 7 (1): 4-6

Evans, E.; j. Marshal and Richard, M.M. (1973). Development of chloroquinox recommendations for mildew control of spring barley. Proc., 7th., Br., Insectic. Fungic. Conf., 1:39-46.

Eyal, Z.; Al-Scharen; J. M. Prescott and Van Cinkel, M. (1987). The septoria disease of wheat; concepts and methods of disease management. Mexico D.F., CIMMYT, 46 pp.

Farouk, S.; K.M. Ghaneem and Abeer A. Ali (1986). Induction and expression of systemic resistance to downy mildew disease in cucumber by elicitors. Egypt. J. phytopathel.; 36 (1-2): 95 -111.

Filella, I.L.; Serrano, J. Serra and Penuelas, J. (1995). Evaluating wheat nitrogen status with canopy reflection indices and diseriminat analysis. Crop science, 35: 1400 – 1405.

Ghobrial, E.; A. M. Hammouda; R. Abdel-Khalek Mostafa, E.E. (1977). Studies on the control of powdery mildew of barley in ARE. Agric. Res. Rev. Min., Agric., 55 (2): 31-38.

Ghobrial, E.; Ikhlas Shafik; R.A. Rizk and Mostafa E.E. (1983). Chemical control of powdery mildew of barley in Egypt. Proc., 5th. Conf Microbiol., Cairo.

Hammouda, A.M.; Mamdouha M. Hussien; O. Boulot and Hoda M. Diab (2001). Inducation of resistance to leaf rust of *Triticum oestivum* by some natural plant and animal derived compounds. Egypt. J. Appl. Sci.; 16 (4): 27-38.

Holliday, P. (1989). A dictionary of plant pathology. Combridge university press, Cambridge, Uk. 369 pp.

Johhansen, H.B. (1964). Loss of yield in spring barley due to attack of powdery mildew. Biol. Abst., 45 (4): 408.

Karadge, B.A. and A.V. Karne (1985). Influence of systemic fungicides, Bavistim and Calixin on *Lycopersicon esculentum* Mill, *leaves*. Biovigyanam, 11.2, 166-168.

Khaleeq, B. and A. Klaatt, (1986). Effects of various fungicides on emergence of three wheat *(Triticum aestivum)* Cultivars. Agron. J., 78 (6): 967 – 970.

Kuc, J. (1991). Plant immunization, Anone pesticide control of plant disease. Petria, 1: 77 – 83.

Large, E.C. (1954). Growth stages in cereals. Illustration of the Feek's Scale. Plant Pathol., 3: 123 – 129.

Lazarovits, G.; K.L. Conn; P.A. Abbasi and Tenuta, M. (2005). Understanding the mode of action of organic soil amendments provides the way for improved management of soilborne plant pathogens. Acta Hortic., 698: 215-224.

Leslie, C.A. and Romani, R. J. (1986). Salicylic acid anew inhibitor of ethylene biosynthesis. Plant cell Rept., 5 (2):144 -146.

Markwell, J.; J.C. Osterman and Mitchell, J.L. (1995). Calibration of the Minolta SPAD-502 leaf chlorophyll meter. Photosynthetica, Res., 46: 467 – 472.

Mercer, P.C. and Mc Gimpsey, H.C. (1986). Fungicidal control of foliar diseases of cereals. Annual Report on Research and technical work of the department of agriculture for Northern Ireland, 131-132.

Monje, O.A. and Bugbee, B. (1992). Inherent limitations of nondestructive chlorophyll meters. A comparison of two types of meters. Hort. Sci., 27: 69 – 71.

Moran, J.A.; A.K. Mitchell; G. Goodmanson and Stockburger, K.A. (2000). Differentiation among effects of nitrogen fertilization treatments on conifer seedling by foliar reflectance: a comparison of methods. Tree physiology 20: 1113 – 1120.

Morsy, A.A.; F. Abd-El-Kareem and Abd-Alla, M.A. (2000). Effect of acetic acid fumigation on common strorage fungi of some grains. Egypt. J. Phytopathol., 28:95-106.

Morsy, A.A.; F. Abd-El-Kareem and Abd-Alla, M. A.(1999). Effect of acetic acid on postharvest decay of strawberry fruits. Egypt. J. phytopathol., 27: 117 – 126.

Mostafa, E.E.; E. Ghobrial; Massarat El-Ghamry and Ikhlas Shafik (1989). Physiologic races and their virulence survey and population shifts of *Erysipha graminis* f.sp *hordei* in Egypt and neighbouring countries. Assiut J. Of Agric. Sci., 20: 261 – 271.

Nair, K.R.S. and Ellingba (1962). A method of controlled inoculation with condiospores of Erysiphe graminis Var. Tritici, Phytopathology, 52:714.

Pancaldi, D. and Brunelli, A. (1988). Chemical control of powdery mildew and rusts in common wheat in Northern Italy. Brighton Crop Production Conference. Pests Dis., 923 – 929.

Pandey, H.N.; T.C. Menon and Rac, M.V. (1989). A simple formulae for calculating area under disease progress curve. Rachis, Vol. 8, No. 2:38-39.

Possingham, J.V. (1980). Plastid replication and development in the life cycle of higher plants. Annu. Rev. plant physiol., 31:113-129.

Rizk, R.A.; M. El-Ghamry; F. EL-Nashar; E. E. Mostafa and Eid, M.A.M. (1991). Sources of resistance and chemical control of barley powdery mildew in egypt. Proc. Of 4th Arab congress of plant protection, Cairo 1-5 Dec.; 1991: 274 – 285.

Schlemmer, M.R.; D.D. Francis; J.F. Shandan and Schepers, T.s. (2005). Remotely measuring chlorophyll content in corn leaves with different nitrogen levels and relative water content. Agron. J.; 97: 106 -112.

Sholberg, P.L.; P.J. Delaquis and Moyls, A.L. (1998). Use of acetic acid fumigation to reduce the potential for decay in harvest crops. Recent Res. Devel. In plant pathol. , 2:31-41.

Sholberg, P.L. and Gaunce, A.P. (1996). Fumigation of High moisture seed with acetic acid to control storage mold. Canad. J. plant Sci., 76:551-555.

Singh, P.J.; P.S. Bedi; H.S. Dhaliwal; K.S. Gill; C.Devkumar and Dureja, P. (1994). Residue analysis of propiconazole in wheat grains. Plant Disease Resarch, 9: 47 – 49.

Snedecor, G.W. and Cochran, G. W. (1967). Statistical Methods. Oxford and J.B.H. Publishing Co.6th edition

Takano, H. (1986). Diniconazole, anew broad spectrum fungicide Japan Pesticide information, 49 : 18 – 22.

Tenuta, M. and Lazarovits, G. (2002). Ammonia and nitrous acid from nitrogenouse amendments kill the microsclerotia of *Veticillium dahliae*. Phytopathelogy, 92: 255-264.

Towsend, G.K. and Heuberger, T.W. (1943). Methods for estimating losses caused by disease experiments. Plant Dis. Rept., 27: 340 – 343.

Tusa, C.; E. Radulescu; L. Draphici; A. Bude and Rasid, A. H. (1982). Some results regarding the efficiency of chemical methods of controlling leaf infection in two – row and six-row barleys, in relation to the variety. Analele Institutului – de Cercetari Pentru Cereale vi Plante Technice Fundulea; 50 : 363 – 372.

Wilson, J.P. (1994). Field and greenhouse evaluation of pearlimillet for partial resistance to *Puccinia substraita* var. indica. Plant Disease, 78: 1202 – 1205.

Wood, C.; D. Reeves and Himelrick, D. (1993). Relationships between chlorophyll meter readings and leaf chlorophyll concentration, N status and crop yield: A review, Proc. Agronomy Soc. New Zealand, 23: 1-9.

المقارنة بين تاثير الاحماض العضوية والمبيدات الفطرية على مقاومة مرض البياض الدقيقى فى الشعير

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اجريت تجارب تحت ظروف الصوبة الزجاجية والحقل، وذلك لتقييم (حمض البروبيونك ، حمض الفورميك وحمض الخليك) واثنين من المبيدات الفطرية المخلقة(سومى-ايت (داى نيكونازول) وفكترا (بروموكونازول)) فى مقاومة مرض البياض الدقيقي فى الشعير و قدرتها على مكافحة الفطر المسبب للمرض.

اتضح من النتائج انخفاض النسبة المئوية لشدة الاصابه بالمرض حوالى 35% كحد اقصى على البادرات المعاملة قبل العدوى باربعة وعشرون ساعة بالثلاثة احماض العضوية السابقة، ومن ناحية اخرى فقد حدث انخفاضا كبيرا ومعنويا فى شدة المرض (تراوح بين 62% الى 81%) فى حالة تلك الاحماض واستخدامها بعد العدوى باربع وعشرون ساعة. كما ادى استخدام المبيدين الفطريين تحت الدراسة (سومى-8 وفكترا) الى الحصول على مقاومة كاملة على بادرات الشعير قبل اوبعد العدوى ب 24 ساعة.

وقد اتضح من النتائج ايضا قدرة كل من الاحماض العضوية والمبيدات المختبرة على تثبيط وتقليل سرعة انتشار وتطور المرض على النباتات المصابة والمعاملة بتلك المركبات باطالة فترتى حضانة المرض (Incubation and latent periods) ((بدرجة معنوية)) عند مقارنتها بتلك التى لم تعامل باى من المركبات تحت نفس الظروف بالصوبة الزجاجية.

اوضحت نتائج التجارب الحقلية، كفءة الثلاث مركبات الطبيعية، والمبيدين المختبرين على مقاومة مرض البياض الدقيقى، فى كل من موقعى تنفيذ التجارب الجميزة والجيزة على السواء ، وظهر ذلك واضحا فى الانخفاض المعنوى فى مساحة الورقة المصابة بالبياض (لنقص فى شدة الاصابة بالمرض عن معاملة المقارنة) وكذلك فىمحدودية المساحة الواقعة تحت منحنى الاصابة بالمرض(AUDPC) وايضا انخفاض قيم معامل الاصابة بالمرض (ACI) ، وذلك بمقارنتها بمعاملة المقارنة " نباتات غيرمعاملة باى من المركبات المختبرة.

ومن ناحية اخرى فقد ادى رش نباتات الشعير (سواء رشة واحدة او رشتين) باى من الاحماض العضوية والمبيدات المختبرة الى تحسين واضح ومعنوى فى مكونات المحصول تحت الدراسة باستثناء عدد الحبوب فى السنبلة. وبوجه فقد اظهرت المعاملة بكل من المبيد الفطرى سومى-8 و حامض البروبونيك عند رشها بمعدل رشتين أعلى كفاءة فى ذلك المجال. حيث نتج عن تطبيق هاتين المعاملتين الى حدوث زيادة معنوية فى وزن السنبلة (بالجرام) ، طول السنبلة (بالسم) وكذلك وزن الالف حبة بالجرام، وذلك بمقارنتها بالنباتات الغير معاملة. لوحظ استجابة ضعيفة نسبيا لمحصول الحبوب فى النباتات التى سبق معاملتها بالحامضين العضويين، (فورميك وخليك) وايضا بالمبيد الفطرى فكترا:

وقد اظهرتالنتائج بوجه عام زيادة كمية الكلورفيل الكلية فى الاوراق وذلك بعد الرش بالمبيد (سومى-ايت) 46.12% والمبيد (فكترا) 64.87% بينما كانت اقل عند استخدام الاحماض العضوية الثلاثية رشه واحدة حيث كان حمض البروبونيك 41.72% ، وحمض الفورميك 33.10% وحمض الخليك 25.95% وعند المعاملة بالرش مرتين وجد انها تعطى زيادة فى المحتوى الكلى للكلورفيل

وعلى الرغم من قلة الكفاءة الحقلية للثلاثة مركبات العضوية تحت الاختبار (احماض البربيونك ، الفورميك والخليك) كمبيدات فطرية فى مكافحة مرض البياض الدقيقى على الشعير بمقارنتها بالمبيدين المختبرين الا انه لكونها مواد طبيعية امنه بيئيا وليس لها اى تاثيرات ضارة على صحة الانسان والحيوان فمن الممكن استخدامها بكفاءة ضمن برنامج مكافحة مرض البياض الدقيقى فى الشعير وخاصة فى المرحلة المبكرة من تطور المرض.