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Effect of Application of some Systemic Fungicides and Resistance Inducing Chemicals on Management of Cantaloupe Powdery Mildew Disease

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The efficiency of some systemic fungicides and resistance inducing chemicals (RICs) on management of cantaloupe powdery mildew, caused by *Erysiphe cichoracearum* DC, was evaluated under greenhouse and field conditions.

Greenhouse experiments revealed that application of the tested systemic fungicides, *i.e.* Master 10%, Rubigan 12%, Sumi-8 5%, Topas 10% and Vectra 10% as well as RICs, *i.e.* Bion, calcium chloride, potassium dibasicphosphate and salicylic acid, significantly reduced the disease severity, meanwhile plant length and foliage fresh weight were increased in comparison with check treatments. However, systemic fungicides were more efficient in this concern than the tested RICs.

Under field conditions, application of either Master 10%, Rubigan 12% or Vectra 10% followed by spraying of calcium chloride or salsylic acid caused significant decrement in the disease severity with significant increment in the fruit yield when compared with check treatments. However, these treatments were, to somewhat, less efficient than application of systemic fungicides only.

Keywords: Cantaloupe, chemical control, fungicides, powdery mildew and resistance inducing chemicals (RICs).

Cantaloupe (*Cucumis melo* L. var. *reticulates* Ser.) is one of the most popular cucurbit crops in Egypt either for local consumption or exportation. It was introduced to Egypt, since few decades, as a winter crop and became one of the most important exportation crops due to the relative advantage of its cultivation, *e.g.* warm winter, enough amounts of water....ect. However, cantaloupe plants are vulnerable to attack by bacterial, fungal and viral diseases in addition to nematode infections and physiological disorders (Osman, 1966; Abo El-Ghar, 1970; Zitter *et al.*, 1996; Brutan, 1997; Agerter *et al.*, 2000; Hilall, 2004 and Muhanna, 2006). Moreover, powdery mildew, caused by *Erysiphe cichoracearum* DC, is one of the most serious diseases affecting cantaloupe production, with a high severity at the time of fruit maturity (Zitter *et al.*, 1996).

It is well known that chemical control of plant diseases mostly causes environmental pollution and increase the accumulated toxic substances in human food chain. On the other hand, using alternative disease management, *e.g.* biological control, plant extracts, antioxidants and agricultural practices, are not enough to obtain efficient results (Hilall, 2004; Muhanna, 2006 and Abada *et al.*, 2008).

Therefore, this work was planned to evaluate the efficiency of some systemic fungicides and/or RICs against cantaloupe powdery mildew, under greenhouse and filed conditions. Also, minimizing the used doses of tested fungicides, in order to avoid or minimize their residues in the harvested fruits, was taken in consideration.

Materials and Methods

Greenhouse experiments:

Five systemic fungicides, *i.e.* Master 10% (prochloraz), Rubigan 12% (fenarimol), Sumi-8 5% (diconazole), Topas 10% (deconazole) and Vectra 10% (bromuconazole) as well as four resistance inducing chemicals (RICs), *i.e.* Bion (bezal 1,2,3 thiadiazole,7 carbothioic acid 5-methylester), calcium chloride ($CaCl_2$), potassium dibasicphosphate (KH_2Po_4) and salicylic acid ($C_7H_6O_3$), were kindly provided from Prof. Kahiry A. Abada, Plant Pathol. Dept., Fac. Agric., Cairo Univ., and evaluated for their effects against the artificial infection of cantaloupe powdery mildew, caused by *Erysiphe cichoracearum* DC, under greenhouse conditions in order to select the most efficient fungicides and RICs.

During mid of March 2006, five cantaloupe seeds (cv. Galia) were sown in each pot (25-cm-diameter), containing sand clay soil (1:1, w:w) disinfested by 5% formalin, then irrigated and left to grow up for 2 weeks before thinned to two plants/plot. The grown plants (5-week-old) were artificially inoculated by shaking naturally infected cantaloupe leaves, five days after spraying with either recommended doses of tested fungicides or 50 mM of tested RICs. Second spray of either fungicides or RICs was applied nine days after artificial inoculation. Five pots were used as replicates for each treatment. The grown plants were irrigated when necessary and fertilized twice, *i.e.* three and five weeks after sowing, by the crystalon compounded (1g/pot). Disease severity was assessed two weeks after the second spray of either fungicides or RICs. Also, plant length (cm) and foliage fresh weight (g/plant) were determined 10 weeks after sowing.

Field experiments:

Field experiments were conducted at Salhyia locality (Behera governorate) during 2007 and 2008 growing seasons to evaluate the effect of three fungicides, *i.e.* Master 10%, Rubigan 12% and Vectra 10%, as well as two RICs, *i.e.* calcium chloride and salicylic acid, against the natural infection of cantaloupe powdery mildew.

Cantaloupe transplants (cv. Galia), 25-day-old, were sown on mid of February under low tunnels until end of March and then in the open air until the end of growing season (mid of June). All agricultural practices, *i.e.* irrigation, fertilization as well as weeds and pests control, were applied according to the standard recommendations of Ministry of Agriculture. When disease symptoms initially appeared on naturally diseased plants, the tested fungicides were sprayed at concentrations of 150ml (Master 10%), 20ml (Rubigan 12%) and 100 ml (Vectra 10%) per 100 litre water, for three times at two week intervals (until three weeks before first harvesting of fruits). Also, one week after the last spray with the tested fungicides, selected RICs were sprayed, at concentration of 50 mM, three times at

two week intervals (until the end of the growing season in mid of June). A set of plants, unsprayed with fungicides or RICs, was served as check treatments. Four plots, each consisted of four rows X 30m long (100 holes/row), were used as replicates for each treatment. The disease severity was assessed for each growing season. Also, fruit yield (kg/plot) was weighed at each harvesting time and the average was calculated.

Disease assessment:

Both artificially and naturally inoculated plants were carefully examined to estimate the severity of infection by powdery mildew depending on the devised scale (0-11) by Horsfall and Barratt (1945) using the following formula:

$$\text{Disease severity (\%)} = \frac{\Sigma (nxv)}{11\,N} \times 100$$

Whereas: n= Number of infected leaves in each category.
v= Numerical values of each category.
N= Total number of the infected leaves.

Statistical analysis:

Obtained data were statistically analyzed using the standard procedures for complete randomized block and split designs as mentioned by Snedecor and Cochran (1967). The averages were compared at 5% level using least significant differences (L.S.D.) according to Fisher (1948).

Results

Greenhouse experiment:

Data presented in Table (1) show that all tested fungicides and resistance inducing chemicals (RICs) caused significant reduction in the severity of powdery mildew with significant increase in plant length and foliage fresh weight of cantaloupe plants in comparison with check treatments. However, tested fungicides were more efficient in these regards than RICs. Vectra 10% was the most effective fungicide followed by Rubigan 12% and Master 10%, as they reduced the disease severity to 2.7, 2.8 and 3.1% and increased plant length to 94.0, 93.7 and 91.0 cm and foliage fresh weight to 192.4, 192.0 and 186.2 g/plant, respectively. Meanwhile, salicylic acid was the most effective RIC followed by calcium chloride, as they reduced disease severity to 15.8 and 16.7% and increased the plant length to 78.4 and 78.1 cm and the foliage fresh weight to 158.0 and 158.2 g/plant, respectively.

Field experiment:

On the basis of the highly efficient, three fungicides, *i.e.* Master 10%, Rubigan 12% and Vectra 10% as well as two RICs, *i.e.* calcium chloride and salicylic acid, were chosen to evaluate their efficiency in managing the natural disease infection under field conditions. Presented data (Table 2) indicate that, in comparison with check treatments, all tested the fungicides and/or RICs caused significant reduction in the natural infection of powdery mildew on cantaloupe plants, and enhanced the average fruit yield in both growing seasons. In this respect, tested fungicides were also more efficient than RICs. Moreover, application of tested fungicides only was

Table 1. Effect of spraying five systemic fungicides and four RICs on the severity of cantaloupe powdery mildew as well as plant length and foliage fresh weight under greenhouse conditions

Treatment		Disease severity (%)	Average plant length (cm)	Average foliage fresh weight (g/plant)
Tested fungicide	Master 10%	3.1	91.0	186.2
	Rubigan 12%	2.8	93.7	192.0
	Sumi-8 5%	4.0	91.2	185.0
	Topas 10%	3.8	91.0	185.0
	Vectra 10%	2.7	94.0	192.4
Tested RIC	Bion	18.8	76.1	151.0
	Calcium chloride	16.7	78.1	158.2
	Potassium dibasicphosphate	21.0	75.0	150.0
	Salicylic acid	15.8	78.4	158.0
Check		47.8	61.2	123.6
L.S.D at 5%		2.3	3.1	2.9

Table 2. Effect of applying systemic fungicides and/or RICs on the severity of powdery mildew and fruit yield of cantaloupe plants (cv. Galia) under field conditions at Salhyia locality during 2007 and 2008 growing seasons

Treatment	Disease severity (%) during		Mean	Average fruit yield (kg/plot) during		Mean
	2007	2008		2007	2008	
Master 10%	3.6	3.2	3.4	231.0	233.3	232.2
Rubigan 12%	3.0	2.9	3.0	236.8	239.0	237.9
Vectra 10%	3.4	3.1	3.3	232.0	234.2	233.1
Calcium chloride ($CaCl_2$)	17.0	16.4	16.7	189.3	190.5	189.9
Salicylic acid (SA)	16.7	16.0	16.4	190.0	191.0	190.5
Master 10% then $CaCl_2$	6.8	6.5	6.7	218.2	220.0	219.1
Master 10% then SA	7.4	7.4	7.4	215.0	216.7	215.9
Rubigan 12% then $CaCl_2$	6.2	6.0	6.1	221.5	223.0	222.3
Rubigan 12% then SA	6.8	6.6	6.7	218.0	220.0	219.0
Vectra 10% then $CaCl_2$	6.0	5.7	5.9	223.4	225.8	224.6
Vectra 10% then SA	6.6	6.8	6.4	219.0	221.0	220.0
Check*	52.4	50.0	51.7	131.1	133.0	132.0
Mean	7.6	7.3	-------	217.7	219.5	-------
L.S.D. at 5% for: Treatment (T)=			2.9			3.6
Season (S) =			n.s.			n.s.
T x S =			3.4			6.2

* Values of the check treatments were not calculated in the mean of the treatments.

more effective in this regard than the application of them followed by tested RICs. On the average, application of Rubigan 12% alone recorded the highest values, either in reducing the disease severity or in rising the average fruit yield (being 3.0% and 237.9 kg/plot, respectively) followed by Vectra 10% (being 3.3% and 233.1 kg/plot, respectively) then Master 10% (3.4% and 232.2 kg/plot, respectively). On the other hand, applying any tested RIC alone recorded, on the average, the lowest efficiency in reducing disease severity (being 16.7 and 16.4%) and low values of fruit yield (being 189.9 and 190.5 kg/plot) for calcium chloride and salicylic acid, respectively.

Discussion

During the few decades, the world is suffering great pollution by many pollutants including pesticides and fungicides. Therefore, the current strategies of pest management, especially on vegetables and fruits, depend on using alternative methods rather than pesticides, fungicides and/or applying these chemicals at the first periods of plant growth prior to fruit maturity. In this respect, cantaloupe plants are liable to infect by powdery mildew and the peak of infection reaches its maximum at the time of fruit harvesting.

Hence, this research aimed to use some resistance inducing chemicals (RICs), as safe substances, in alteration with some systemic fungicides, in order to control cantaloupe powdery mildew. These fungicides were sprayed at the first period of infection (before fruit maturity) to minimize the infection for a period of about 45 days (the time of fruit formation until pre-maturity), meanwhile spraying RICs before and during the fruit harvesting in order to obtain fruits free of fungicides residues and/or with permitted fungicides ratio.

The obtained data of pot experiment showed that the tested fungicides, *i.e.* Master 10%, Rubigan 12%, Sumi-8 5%, Topas 10% and Vectra 10% as well as RICs, *i.e.* Bion, calcium chloride, potassium dibasicphosphate and salicylic acid, caused significant reduction in the disease severity with significant increase in length and foliage fresh weight, compared with check treatments. On the other hand, fungicides were more efficient than RICs in this regard. It is well known that fungicides, especially systemic ones are more efficient in management of many fungal diseases including cantaloupe powdery mildew (Abdel-Rahman, 1976 and McGrath, 2001). Also, RICs were reported as alternative and/or safe trial for management of many diseases, especially those of vegetable crops (Metranx and Boller, 1986; Abo-Taleb, 2000; Hilall, 2004; Muhanna, 2006 and Abada *et al.*, 2008).

It has been found, from field experiments, that spraying cantaloupe plants three times with any of Master 10%, Rubigan 12% or Vectra 10% in alternation with another three sprays with any of calcium chloride or salicylic acid as RICs resulted in significant reduction in the disease severity with significant increase in the fruit yield when compared with unsprayed (check) plants. However, these treatments were of low efficiency compared with spraying the tested fungicides only and still of high efficiency when compared with spraying of RICs only. Although, the

alternations between the tested fungicides and RICs gave intermediate effect on disease reduction and the produced fruit yield, but it could be of great interest, where the produced fruits are of low fungicides residue, which the long period after the latter fungicides spray is capable to cause metabolic changes to be not poisoned (Abada *et al.*, 2005).

The reduction in cantaloupe powdery mildew herein is due to the effect of the tested fungicides and RICs each alone or in alternation with them. In addition, the role of fungicides in reducing the disease is well known (McGrath, 2001) and the role of RICs is explained by many hypothesis, where induced acquired resistance was induced by restricted infection is not due to a specific component of the pathogen, but rather to gradual appearance and persistence of a level of metabolic perturbation leading to stress on the host. Doubrava *et al.* (1988) mentioned that induced acquired resistance is persistent and generally is pathogen nonspecific. In addition, Larcke (1981) found that unlike elicitors of phytoalexins accumulations, which are elicited at the site of application, may be responsible for localized protection and induces systemic acquired resistance that sensitizes the plant response rapidly after infection. Theses responses induced phytoalexins accumulation and lignifications and enhance activities of chitinase and β-glucanase (Dean and Kuc, 1985 and Metranx and Boller, 1986). Furthermore, Kessmann *et al.* (1994) reported that the mechanism of systemic acquired resistance is apparently multifaceted, likely resulting in stable broad spectrum disease control and they could be used preventatively to bolster general plant health, resulting in long lasting protection.

The use of RICs was previously reported as alternative method for controlling many powdery mildew diseases including powdery mildew of cantaloupe (Larcke, 1981; Ibrahim, 1998; Abo-Taleb, 2000; Fouly, 2004; Hilall, 2004 and Abada *et al.*, 2008).

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تأثير استخدام بعض المبيدات الجهازية والكيماويات المستحثة للمقاومة علي مكافحة مرض البياض الدقيقي في الكانتالوب

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تم اختبار فعالية رش بعض المبيدات الفطرية الجهازية والكيماويات المستحثة للمقاومة علي مكافحة مرض البياض الدقيقي في الكانتالوب المتسبب عن الفطر ايرسيفي سيكوراسيرم في تجارب أجريت تحت ظروف كل من الصوبة والحقل.

وقد أوضحت نتائج تجربة الصوبة أن المبيدات الجهازية ماستر و روبيجان و سومي-٨ وتوباس وفيكترا والكيماويات المستحثة للمقاومة وهى كلوريد الكالسيوم وفوسفات البوتاسيوم ثنائية القاعدية وحامض السالسيليك تسببت في إحداث انخفاض معنوي للمرض مع حدوث زيادة معنوية لطول النبات والوزن الطازج للمجموع الخضري مقارنة بمعاملة الكونترول. ومع ذلك فقد كانت المبيدات الجهازية أكثر فعالية في هذا المضمار مقارنة مع الكيماويات المستحثة للمقاومة.

وقد أجريت تجارب حقلية خلال موسمي ٢٠٠٧ و ٢٠٠٨ لتقييم رش نباتات الكانتالوب بالمبيدات الجهازية ماستر ، روبيجان ، فيكترا ثلاث رشات ثم رش الكيماويات المستحثة للمقاومة وهي كلوريد الكالسيوم وحامض السالسيليك ثلاث رشات أخرى لدراسة تأثيرها علي مكافحة الإصابة بمرض البياض الدقيقي. وقد أوضحت النتائج المتحصل عليها ان هذا التعاقب بين الرش بالمبيدات الفطرية ثم الرش بالكيماويات المستحثة للمقاومة قبل الحصاد بوقت كافى أحدث نقص معنوي للمرض مع إحداث زيادة معنوية في المحصول الناتج مقارنة بمعاملة الكونترول وكذلك مقارنة بمعاملات الرش بالكيماويات المستحثة للمقاومة فقط. وبالرغم من ذلك فقد كانت هذه المعاملات المتعاقبة ذو فعالية منخفضة لحد ما في مكافحة المرض وإنتاج المحصول وذلك عند مقارنتها مع الرش بالمبيدات الفطرية فقط.