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Controlling Downy and Powdery Mildews of Bill Pepper Using Fungicides Alternatives under Plastic Houses Conditions

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Abstract-Evaluation the efficacy of resistance chemical inducers as foliar spray against Bell pepper downy and powdery mildews diseases was carried out under plastic house conditions. Potassium bicarbonate, Chitosan, potassium monohydrogen phosphate, Saccharin and Ascorbic acid resistance chemical inducers were evaluated. The recorded foliar diseases Downy and powdery mildews of pepper were significantly reduced at all treatments comparing with fungicide treated plants. Similar results were also recorded for the obtained accumulated Bill pepper yield. The lowest downy mildew disease incidence was recorded as 9.8, 13.4% at treatments of Potassium bicarbonate and Chitosan. Meanwhile, potassium monohydrogen phosphate, saccharin and ascorbic acid showed moderate effect on disease incidene ranged between 13.4-17.2%. The highest disease incidence 23.4% was recorded at the fungicide Ridomil Gold treatment. Similar trend on powdery mildew incidence was observed at the same treatments. Also, the calculated accumulated yield was increased by 48.2, 38.6, 34.5, 22.4 and 13.2% over that obtained of control plants sprayed with the fungicide Ridomil Gold, in respective order with applied treatments, Potassium bicarbonate, Chitosan, potassium monohydrogen phosphate, saccharin and ascorbic acid. On the light of the present study it could be suggested that the usage of combined application of resistance plant chemicals might be used as easily applied, safely and cost effective control methods against such foliar plant diseases.

***Index Terms*-Downy mildew, Pepper, powdery mildew, plant resistance inducers, plastic houses.**

I. INTRODUCTION

Pepper (*Capsicum annuum* L.) is one of widespread vegetables grown worldwide. Bell pepper, also known as sweet pepper or a pepper (in the United Kingdom and Ireland) and capsicum (in India, Australia, Singapore and New Zealand), is a cultivar group of the species *Capsicum annuum* L. Cultivars of the plant produce fruits in different colors, including red, yellow, orange, green, chocolate/brown, vanilla/white, and purple. Bell peppers are sometimes grouped with less pungent pepper varieties as "sweet peppers". Peppers are native to Mexico, Central America and northern South America. Pepper seeds were later carried to Spain in 1493 and from there spread to other European, African and Asian countries. Today, China is the world's largest pepper producer, followed by Mexico and Indonesia. Recently Bell pepper is considered a new cultivar in plastic houses under protected cultivation system in Egypt. Generally, pepper plants are attacked with several root and foliar diseases. The most serious foliar diseases are Downy and Powdery mildews. It was reported that [1] downy mildew caused by the pathogen *Peronospora parasitica*, can develop during the winter vegetable season. Cool damp weather with high relative humidity and air movement stimulates disease development by promoting sporulation, spore dispersal and plant infection by the pathogen. Successful management of downy and powdery mildews can be achieved by planting cultivars that are tolerant or resistant to the pathogens. If susceptible cultivars are grown, it is extremely important to have chemical protection in place when environmental conditions become favorable for diseases development. Several new agrochemicals are in development that has activity on the pathogens that cause downy mildew diseases. In this regards, Application of sodium bicarbonate or calcium chloride significantly reduced the early blight incidence and severity [2]. They added that Calcium chloride proved higher efficacy for reducing both disease incidence and severity than that of sodium bicarbonate when applied either alone or combined with *Saccharomyces cerevisiae*. Moreover, it was found that potassium bicarbonate applications were effective in reducing the severity of powdery mildew on *E. japonica* and pumpkin [3,4]. Moreover, Chiosan, in recent years, the importance of chito-saccharides as plant growth promoting and disease control agents has been emphasized [5,6]. Chitosan has been shown to induce defense responses in different plants [7,8]. Therefore, the objective of the present study was designed to evaluate efficacy of some plant resistance inducers as foliar spray against downy and powdery mildew diseases of Bill pepper plants growing under plastic house conditions.

II. MATERIALS AND METHODS

Evaluation of some plant resistance inducers under natural infestation with Bill pepper foliar diseases causal organisms against downy and powdery mildews infection was performed under protected cultivation system conditions in commercial plastic houses Researches and Experimental Station of National Research Centre (NRC), at Nubaria region, Beheira Governorates. Evaluating the efficacy of different plant resistance inducers treatments against downy and powdery mildews infection were applied as foliar sprays treatment as follows:

1. Potassium bicarbonate (20mM)
2. Chitosan (0.05mM)
3. Potassium monohydrogen phosphate (20mM)
4. Saccharin (3mM)
5. Ascorbic acid (20mM)

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6. Control (received only the recommended fungicide Ridomil Gold at the rate of 200 g/100L

The experimental plastic house consists of 6 rows, each (0.9 x 60m, width x long) divided into 3 parts 20m long of each, and every part considered as one replicate. Three replicates were used for each particular treatment in complete randomized block design. The growing Bill pepper were sprayed with proposed treatments 3 times with 15 days intervals after transplanting. The growing Bill pepper in plastic house received traditional agricultural practices, *i.e.* irrigation, fertilization, etc. Monitoring and scouting of foliar diseases incidence of downy and powdery mildews of Bill pepper were recorded. Percentages of disease incidence were recorded at 60, 90 and 120 days of transplanted date. At the end of growing season the obtained accumulated yield was calculated. for each particular treatment.

Disease Assessment

Percentage of each foliar disease incidence was recorded as the number of diseased plants relative to the number of growing plants for each treatment, then the average of disease incidence in each treatment was calculated.

Statistical analysis:

Tukey test for multiple comparisons among means was utilized [9].

III. RESULTS AND DISCUSSION

Evaluation of some plant resistance inducers under natural infestation against downy and powdery mildews infection of Bill pepper foliar diseases was performed under plastic house conditions**.** The obtained results in Table (1) showed the downy mildew incidence of Bill pepper plants. Presented data revealed that all applied treatments have positive effect against disease incidence comparing with control. Percentage of downy mildew incidence increased as the plants grow up to reach their maximum at 120 day of growth. At this plant age, announced highly significant effect of treatments, Potassium bicarbonate (9.8%), followed by Chitosan (13.4) comparing with 23.4% which recorded at fungicide treatment. Moreover, these applied treatments could suppress completely the downy mildew incidence more than 60 days of growing Bill pepper plants under natural infestation comparing 6.8% disease infection recorded at fungicide treatment. The other applied treatments, Potassium monohydrogen phosphate, Saccharin and Ascorbic acid showed moderate effect against disease incidence recorded as 15.7, 16.2 and 17.2% at 120 days of plant growth, respectively. Similar trend was observed concerning powdery mildew incidence of Bill pepper in response to all applied plant resistance inducers (Fig. 1). Illustrated data showed that powdery mildew is not detected more than 60days of plant growth at applied treatments of Potassium bicarbonate and Chitosan then started to be recorded as 6.3, 5.4% and 7.8, 9.4% at 90 and 120 days of plant growth.

Table 1: Percentage of Downy mildew disease incidence in response to application of different plant resistance inducers against foliar diseases of pepper grown in plastic houses

Treatment	Downy mildew incidence %		
	Days of transplanting		
	60	90	120
Potassium bicarbonate	0.0 a	7.3 d	9.8 e
Chitosan	0.0 a	6.7 c	13.4 f
Potassium monohydrogen phosphate	2.7 b	5.7 c	15.7 g
Saccharin	2.9 b	7.3 d	16.2 g
Ascorbic acid	3.4 b	8.9 d	17.2 h
Ridomil Gold	6.8 c	17.3 h	23.4 i

Mean values within columns followed by the same letter are not significantly different ($P \leq 0.05$).

Data also showed that treatments of potassium monohydrogen phosphate, saccharin and ascorbic acid showed 11.2, 12.7 and 14.2% powdery mildew incidence, respectively at 120 days of plant growth comparing with 18.4% at fungicide treatment.

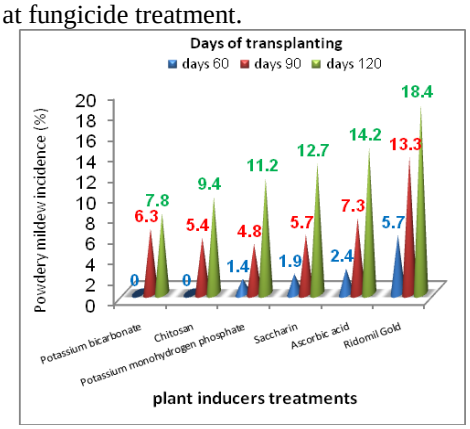

Fig. (1) Percentage of powdery mildew disease incidence in response to application of different formula against foliar diseases of pepper grown in plastic houses

Application of different plant resistance inducers as foliar spray resulted in reduction of foliar diseases incidence which reflected positively in plant stand and its healthy growth as well as its produced yield. Bill pepper plants grown in plastic house sprayed with potassium bicarbonate, Chitosan and potassium monohydrogen phosphate produced the highest significant accumulated yield recorded as 1,192; 1,111 and 1,078 Ton/ plastic house, respectively (Table 3). Data also showed that significant accumulated yield was obtained from plants sprayed with either saccharin or ascorbic acid which recorded as 0.982 and 0.908 Ton/ plastic house comparing with 0,502 Ton/ plastic house obtained at fungicide treatment.

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Table (2) The obtained yield of Bill pepper in response to application of different plant resistance inducers under plastic houses conditions

Treatment	Av. yield Kg/row	Av. yield Ton/ plastic house
Potassium bicarbonate	198.7g	1, 192
Chitosan	185.3f	1, 111
Potassium mono hydrogen phosphate	179.8d	1, 078
Saccharin	163.6c	0, 982
Ascorbic acid	151.3b	0, 908
Fungicide (Ridomil Gold)	133.6 a	0, 502

Mean values within columns followed by the same letter are not significantly different ($P \leq 0.05$).

Illustrated data by Figs (2) represent increase (%) in the obtained yield of Bill pepper in response to foliar application with different plant resistance inducers in plastic houses under protected cultivation system. The calculated accumulated yield was as 48.2, 38.6, 34.5, 22.4 and 13.2% over that obtained of control plants sprayed with the fungicide Ridomil Gold, in respective order with applied treatments, Potassium bicarbonate, Chitosan, potassium monohydrogen phosphate, saccharin and ascorbic acid. In the present study the obtained results showed high efficacy of application plant resistance inducers Potassium bicarbonate, Chitosan, Potassium monohydrogen phosphate, saccharin and ascorbic acid as foliar spray treatment during the growing growth season against downy and powdery mildews of Bill pepper plants. Sprayed treatments, could suppress incidence of both downy and powdery mildews and increase the obtained yield over control of pepper plants. These results are confirmed with those obtained by several investigators. The obtained reduction in invaded vegetable plants with downy and powdery mildews pathogens may be attributed to the role of sprayed chemical induce resistance which acts as elicitors of plant defense reactions against pathogenic fungi. Similar explanation was reported by various workers. In this concern, some chemicals were reported as resistance inducers against plant diseases.

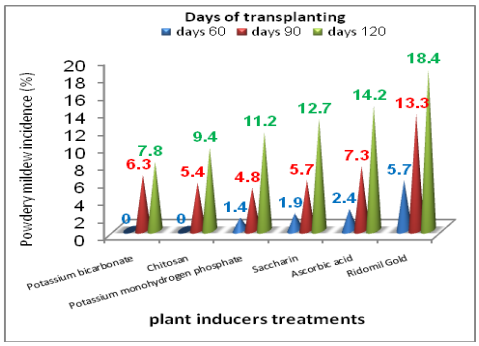

Fig. (1) Percentage of powdery mildew disease incidence in response to application of different formula against foliar diseases of pepper grown in plastic houses

The induced resistance or the acquired resistance is a kind of resistance produced by plant infected by pathogens or treated by chemical materials, which can protect plant from the subsequent infection of plant pathogens [10]. Plants can acquire partial or systematic resistance when they were induced by different biological or a biotic elicitors, and these elicitors can activate a special dot of signal web by different signal route, then they induce different plants to produce special protein for resisting the attack of pathogens and pests. The effects of foliar salt applications have been previously studied using K_2HPO_4, KH_2PO_4 at pH 4.5 or 9.3, KNO_3, KCl, K_2SO_4, and $NH_4H_2PO_4$ at concentrations ranging from 20 to 100 mM which were effective in significantly reducing *Sphaerotheca fuliginea* on cucumber [11,12,13]. In further experiments, [13] found that foliar applications of 25 mM of K_2HPO_4 or KH_2PO_4 on a 7- or 14-day schedule were highly effective in controlling natural infection of cucumber powdery mildew. Furthermore, bicarbonate salts have broad-spectrum antimicrobial properties and are recognized by the food industry as compounds innocuous to human health. Therefore, bicarbonates are promising compounds for use with fresh vegetables that are eaten uncooked. This would eventually allow replacing or reducing the use of synthetic fungicides, whose use is increasingly questioned because of their potential danger to human health [14]. Also, [15] stated that bicarbonates are effective against food bacterial and yeast infections and are important in controlling buccal pathogens [16]. Likewise, some of the effects of bicarbonates on microorganisms are associated with CO_2 activity [17]. For example, sodium, potassium, and ammonium bicarbonate made it possible to control some fungal infections of the cucumber during preharvest [3,18]. Similarly, they control among others, powdery mildew caused by *Leveillula taurica* (Lév.) Arn. [19], *Oidium euonymi japonici* (Arcang.) Sacc. [4] and *Sphaerotheca pannosa* (Wallr.:Fr.) Lév. var. *rosae* Woronichin [20]. Moreover, [21] reported that the inhibitory effect of $KHCO_3$ on *B. cinerea* in tomato fruit has also been observed in *Capsicum annuum* (pepper plant). On the other hand, the antioxidant Chitosans is reported to influence the production of substances related to stress response, such as phytoalexins [22] and chitinases [23,24]. It is suggested that chitosan can be used commercially for controlling tomato root rot diseases under field conditions [25]. Trials conducted in tomatoes [26] showed that foliar applications of chitosan resulted in yield increase of nearly 20% and a significant improvement in powdery mildew disease control. Chitosan treatments have plant growth promoting effects, resulting in improved yields and plant health in numerous crops and fruits. The activation of protective mechanisms in plant tissues with chitosan inhibited the growth of taxonomically different pathogens [27]. It has been considered as an alternative to chemical fungicides [24,28,29]. The present findings demonstrate that plant resistance inducers may have important implications for the future use on a commercial scale for controlling such diseases especially under protected cultivation regime. With results such as those reported here, foliar salt applications could become effective components of an integrated disease management system for Bill pepper. It is also suggested that such application trials with mildews on other vegetable crops be conducted

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