

# Evaluation of the efficiency of some chemical compounds in controlling powdery mildew in Zucchini

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Received: 05 March 2018

Accepted: 21 March 2018

Online: 26 March 2018

## ABSTRACT

This study was carried out through the season 2016-2017 in the greenhouses of Horticulture office/ Department of Researches and Studies/ Ministry of agriculture. The study aim was to evaluate the efficiency of some chemical agents in controlling powdery mildew (PM) on Zucchini, and to study the mechanism of action of these compounds on the causal agent, estimate the value of controlling on PM, determine the total chlorophyll, the leaves area, and the productivity. The results of six sprays with seven days between each spray showed many differences between Potassium Bicarbonates (PB) 3 g/L, 5 g/L, Potassium Silicates (PS) 3g/L, 5g/L, Sodium Silicates (SS) 3g/L, 5g/L, and MEGAVIL pesticide. There were no significant differences in % of disease severity between (PB) 5g/L and MEGAVIL. AUDPC showed significant differences between MEGAVIL and (PB) 5g/L with 91.92 and 113.75 respectively, the total AUDPC were between 739.37 and 388.50 for (PB) 3g/L, (SS) 3g/L, (SP) 3g/L, (SP) 5g/L, and (SS) 5g/L. while the treatment of control recorded highest value 1.727.32. AUDPC for the treatments were between 18.37 and 147 comparing with control 345.44. The results of leaves spraying referred that no significant differences between MEGAVIL and (PB) 5g/L with controlling value 94.80% and 99.35% respectively, while (SS) 3g/L, (PB) 3g/L, (SP) 3g/L, (SP) 5g/L, and (SS) 5g/L were 67.52, 68.17, 77.26, and 77.57% respectively. The results of total chlorophyll showed that MEGAVIL treatment was the highest with 69.48 followed by (PB) 5g/L and (PB) 3g/L with 60.08 - 66.40 respectively, whereas no significant differences between (SS) 5g/L and (SP) 5g/L with chlorophyll content 48.44- 52.40 respectively. The highest value for leaves area was with MEGAVIL treatment 106.46 cm<sup>2</sup> followed by (PB) 5g/L and (PB) 3g/L with 85.08-99.04 and (SP) 3g/L with 76.76 cm<sup>2</sup>, the lowest value of leaves area recorded with MEGAVIL 45.91 cm<sup>2</sup> comparing with control 38.04. The results showed significant increasing in productivity of one plant in all treatments with average between 1090-1410 g/plant comparing with control 618 g/plant. No significant differences between MEGAVIL, (PB) 5g/L, and (PB) 3g/L with 1340-1380, and 1410 g/plant respectively. There were reversal relationship between the productivity and total AUDPC.

**Keywords:** *Cucurbita pepo*, *Sphaerotheca fuliginea*, *Erysiphe cichoracearum*.

## 1. INTRODUCTION

Zucchini (*Cucurbita pepo*) is one of popular consumed vegetables in Iraq, and belongs to Cucurbitaceae family. The productivity of Zucchini in Iraq is 30.600 tons in 2016, and Baghdad is the highest production, followed by Wasit with 2.500-10.200 tons per year, on the other hand the yield in one hectare is 13.600 kg in Kirkuk, followed by 12.000 kg in Samawa ]1[. Zucchini planted in many countries over the world, it is consumed as

food, medical treatment, and the seeds considered a rich source of protein and oil ]2[. Zucchini planted in all parts of Iraq especially in the middle and northern of Iraq, in greenhouses and field ]3[. The original homeland for Zucchini is middle and northern site of America, and it its spread over of the world ]4[. There are many important diseases which can cause loses in quality and quantity of yield, Powdery Mildew (PM) is

considered one of these diseases. It's spread in all over of the world, caused by *Sphaerotheca fuliginea* and *Erysiphe cichoracearum* [5]-[6]. Symptoms of PM can appear as white powdery spots on the surface of leaves, the spots contain the spores and conidiophores. Other parts of plant can be infected by PM like the flowers and fruits and cause dwarfing pathogen forming closed fruit bodies with brown or black color [7]. Many studies approved that PM can be caused by *Sphaerotheca fuliginea* and it can cause losing in the yield of cucurbits [8]-[9]. [10] reported that PM on zucchini can cause by *S. fuliginea* and *E. cichoracearum*. The studies approved that spraying or ground application of Potassium silicates (PS), and sodium silicates (SS) can reduce the level of disease severity in many plants like Grape, Strawberry, wheat, Zucchini, and cucumber [11]. Spraying Silicon Solution on several cucurbits can reduce the ability of pathogen to penetrate the leaves surface through accumulating and increase the thickness of cell walls and average of stems length [12]. Potassium Bicarbonates (PB) salts were used as protection again to decrease the risk of infection in many diseases such as PM on apple, dry rot in tomato, tomato leaf spot, gray mold on grape and PM on tomato [13]-[14]-[15]. There are no studies in Iraq mentioned using (PS), (SS), and (PB), so this study was carried to evaluate the efficiency of some chemical compounds in controlling PM on Zucchini in greenhouse conditions.

## 2. MATERIALS AND METHODS

### 2.1 Culture and pathogen inoculation

This study carried out in a research station affiliate to Horticulture office/ Department of researches and studies/ Ministry of Agriculture. Many infected plants with PM were collected from field to obtain inoculation, conidia were harvested by using sterile brush. Concentration  $1 \times 10^6$  spore/ml was prepared and calculated by using haemocytometer. On 8-Dec-2016, variety Tilet of Zucchini plants were inoculated after 40 days from planting by spraying the upper surface of leaves with 2L volume sprayer [16]. Optimum environmental conditions for infection were prepared through closing the greenhouse doors, adding cloth close to the plants, and heavy irrigation to obtain high humidity.

### 2.2 Effect of foliar spraying by chemical compounds on disease progress under greenhouse conditions

Number of chemical compounds were evaluated in this study, Potassium Bicarbonates (PB) 3g/L, 5g/L, Potassium Silicates (PS) 3g/L, 5g/L, Sodium Silicates (SS) 3g/L, 5g/L, Zucchini plants were sprayed six times with seven days period between each spray. The first spray applied after seven days from the date of pathogen inoculation. All the treatments were arranged as below:

- 1- Control (only water).
- 2- Spraying (PB) 5 g/L on leaves up to wetting.
- 3- Spraying (PB) 3 g/L on leaves up to wetting.
- 4- Spraying (PS) 5 g/L on leaves up to wetting.
- 5- Spraying (PS) 3 g/L on leaves up to wetting.
- 6- Spraying (SS) 5 g/L on leaves up to wetting.

- 7- Spraying (SS) 3 g/L on leaves up to wetting.
- 8- Spraying MEGAVIL pesticide (1 ml/L), active ingredient is Hexaconazole, Meghmani Industries Limited, India

Each treatment were divided into four replications with one plant, twenty leaves were marked. Disease severity was scored weekly for 45 days by following the disease scale as below:

- 0= no infection
- 1= 1-25% leave area is infected.
- 2= 26-50% leave area is infected.
- 3= 51-75% leave area is infected.
- 4= 76-100% leave area is infected.

Percentage of disease severity was calculated by following McKinney equation [17].

%Diseases severity =  $\frac{\text{Sum (disease rating} \times \text{disease index)}}{\text{Total No. of rating} \times \text{highest rating}} \times 100$

AUDPC calculated weekly through following the equation [18]:

$$\text{AUDPC} = \frac{(Y_i + Y_{(i+1)})}{2} \times (t_{(i+1)} - t_i)$$

Where: AUDPC= (Area Under Disease Progress Curves); (Y<sub>i</sub>)= disease severity in the first reading; Y<sub>(i+1)</sub>= disease severity in the second reading; (T<sub>i</sub>)= the first time; T<sub>(i+1)</sub>= the second time.

Percentage of disease control was calculated after 83 days from planting date according to the equation below [19]:

$$\text{Disease severity \%} = \frac{\text{disease severity in control} - \text{disease severity in treatment}}{\text{disease severity in treatment}}$$

### 2.3 Effect of foliar treatment with chemical compounds on total chlorophyll and leaves area under greenhouse conditions

The total chlorophyll in the leaves was calculated by using Chlorophyll meter, spad- 502, Manufactured in Japan. The results recorded by selecting the fifth leave from each plant. leaves area was calculated by following the protocol of [20]: 10 holes (2 cm dim) of plant desks was taken by using borer cork from each leaf, the holes were dried with the leaves in 50-60 °C and weighted by electronic scale. The leaves area was calculated through the following equation [20]:

$$\frac{\text{desks weight}}{\text{leaves weight}} = \frac{\text{desks area}}{\text{leaves area}}$$

The total yield was calculated after 45 from planting by weighting the fruits of two plants from each treatment. The result was analyzed depending on (RCBD) Simple Randomized Complete Block design, by using (SAS Program) Statistical Analysis System. The significant differences compared depending on (LSD) under 0.05.

### 3. RESULTS AND DISCUSSION

#### 3.1 Effect of foliar treatment of the chemical compounds in the progress of PM under greenhouse conditions.

##### 3.1.1 The Effect in disease severity.

The results of table (1) refer to significant differences in disease severity between the treatments from 43 to 83 day. Potassium Bicarbonates (PB) 5 and 3 g/ L recorded lowest disease severity in the first week with 0% , while the highest value of disease severity was (PS) 5g/ L with 6.25% . Both (PS ) 3 g/L and (SS) 5 g/ L recoded the same result with 2.5% .The results after 55 days showed on significant differences between (PB) 3g/L, (PB) 5g/L, and MEGAVIL with disease severity 3.75 ,5 , 6.25 respectively, on the other hand (PS) 5g/L and (PS) 3g/L recorded the same results with 12.5% compared with control treatment 36.25%, while the lowest disease severity recorded in MEGAVIL with 1.25% Followed by (PB) 5g/L with 5%, the highest disease severity was in ( SS) 3g/L with 21%, on significant statistical differences between (SS) 3g/L and (PB) 3g/L with 10, 11.25% respectively . The results after 69 days from planting showed that (PB) 5g/L recorded 0% followed by MEGAVIL and (PB) 3g/L with 2.5 , 10 % respectively , no significant differences results between (SS) 3g/L and (PS) 3g/L with disease severity 10,12.5% comparing with control 58% . The results after 76 days from planting referred that on significant difference between MEGAVIL and (PB) 5g/L with 0, 1.25 % respectively. The highest significant reduction in disease severity after 6 sprays was in MEGAVIL treatment, followed by (PB) 5g/L and (PB)

3g/L with 1.25, 8.75, and 25.5% respectively in comparison with (PS) 3g/L (SS) 3g/L , (SS) 5g/L , (PS) , and control with 25 , 28.75 , 35 , 36.25 , 96.25 % respectively. Potassium Bicarbonates (PB) was considered as good treatment for controlling PM on zucchini through spraying on the infected plants, [21] approved that PB was effective in reducing the infection in Powdery mildew (PM) on zucchini, also he referred the ability to use (PB) in integrated management of PM in cucurbits. The mechanism of action of (PB) in the causal agent of PM has come from the direct affection in permeability of cell membranes and destroying the cell wall of hyphae [22]-[23]. Sodium Silicates (SS) and (PS) is considered as effective agent in controlling PM, because the ability of plants to absorb the silicon through the cuticle, transform, and storage in walls of epidermis and another locations in the plant, so that the accumulation of silicon can increase the rigidity of cell walls and increase the plant defenses against the pathogens through the role of physical defense [24]. [25] reported that the spraying of cucumber leaves by silicon leads to significant reduction in severity of which caused by *Podosphaera xanthi*, he supposed that accumulation of silicon on the surfaces of leaves acting the role of physical obstacle or through the osmotic effect of high concentrations of silicon. [26] mentioned that spraying the leaves of strawberry by Omex SW7 (a compound consisting silicon) with different concentrations led to increase in density and length of the filaments on the surface of leaves so that reduced conidia germination for the pathogen *Sphaerotheca aphanis*.

**Table 1.** Effect of foliar spraying for the chemical compounds in disease severity percentage of PM on Zucchini under greenhouse conditions.

No.	Treatments	48Day	55 Day	62 Day	69Day	76 Day	83 Day	LSD
1	PS 5g/L	6.25	12.5	17.5	17.5	25	36.25	6.39 *
2	PS 3g/L	2.5	12.5	13.5	12.5	18.75	25	6.07 *
3	SS 5g/L	2.5	8.75	21.25	23.75	27.5	35	* 6.46
4	SS 3g/L	1.25	5	11.25	10	15	28.75	* 7.03
5	PB 5g/L	0	5	5	0	1.25	8.75	* 3.59
6	PB 3g/L	0	3.75	10	10	20	23.5	* 5.83
7	MEGAVIL	5	6.25	1.25	2.5	0	1.25	* 2.78
8	Control	6.25	22.5	36.25	58	78.75	96.25	* 13.49
	LSD	* 2.59	* 5.04	* 5.66	* 7.39	* 6.29	* 11.94	---

#### 3.2 Effect of chemicals treatment on AUDPC

The table (2) shows significant differences between the treatments for AUDPC. The results of AUDPC1 showed that (PB) 3g/L and (PB) 5g/L was the lowest value of AUDPC with 25 and 26 respectively, while MEGAVIL recorded 26.37 comparing with control 100.62. No statistical differences between (PR) 5g/L and MEGAVIL for AUDPC2 with 35.06, 26.25 respectively, on the other hand (PS) 5g/L and (SS) 5g/L were the same value with 105. AUDPC3 results showed that (PB) 5g/L recorded 17.5 followed by MEGAVIL with 13.12, while (PB) 3g/L, (SS) 3g/L, and (PS) 3g/L showed reduction in AUDPC

value with 56.87, 70, and 91.87 respectively, comparing with control 329.87. The results of AUDPC4 showed that (PB) 5g/L recorded 4.37, Followed by MEGAVIL treatment with 8.75, at the same time (SS) 3g/L, (PB) 3g/L, and (PS) 3g/L showed decreased in value of AUDPC with 87.50, 105, and 109.37 respectively, comparing with control 478.62. AUDPC5 showed on significant differences between (PB) 5g/L and MEGAVIL, with 91.87 and 113.75. The highest value in AUDPC average and total AUDPC were in control with 345.44 and 1.727.32. Reducing in the value of AUDPC in all treatments may be because the effect in disease

severity and the reaction between the pathogen and the host plant, and the environment conditions. This agrees with [27] who referred that spraying the leaves of water melon by silicon can effect in expansion of the colonies of *Podosphaera xanthi* reducing conidia production, and decreasing the number of disease

cycles, as a reason effecting in disease severity disease progress, and the factors of natural epidemiology. The mechanism of effect of bicarbonates against the fungi was through inhibition of cell membranes permeability destroying the cell walls of mycelium [22].

**Table 2.** Effect of foliar treatment of chemical compounds in AUDPC of PM on Zucchini leaves under greenhouse conditions.

Treatments	AUDPC1	AUDPC2	AUDPC3	AUDPC4	AUDPC5	Average	Total	LSD
PS 5g/L	65.62	105	122.5	148.75	214.37	131.25	656.25	63.55 *
PS 3g/L	83.12	91.87	91.87	109.37	153.12	105.87	529.37	51.96 *
SS 5g/L	78.75	105	157.5	179.37	218.75	147.87	739.37	57.33 *
SS 3g/L	56.87	56.87	74.35	87.5	135.12	82.15	410.75	42.18 *
PB 5g/L	26.25	17.5	17.5	4.37	48.12	22.75	113.75	23.07 *
PB 3g/L	26.25	35	70	105	152.25	77.7	388.5	37.85 *
MEGAVIL	39.37	26.25	13.12	8.75	4.37	18.37	91.87	27.71 *
Control	100.62	205.62	329.87	478.62	612.5	345.44	1.727.32	14.39 *
LSD	16.82 *	27.07 *	33.62 *	39.21 *	46.82 *	M 11.75 *	27.78 *	---

**3.3 Effect of foliar treatment of chemical compounds in disease in zucchini under greenhouse conditions.**

The results of table (3) refer that all treatments reduced PM on zucchini. The percentage of control was between 67.52 and 99.35. MEGAVIL treatment was the highest value with 99.35%. No significant differences between MEGAVIL and (PB) 5g/L with 99.35, 94.80 respectively. The percentage of PM reduction were 67.52 , 68.17 , 77.26 , 77.54, and 77.65 in (SS) 3g/L, (PB) 3g/L, (PS) 3g/L, and (SS) 5g/L respectively. These results were in agreement with [13]-[14], they reported

that PB was an efficient agent in reducing PM on apple and tomato, PB has many mechanisms to antagonisms with pathogens [28], same role of fungicides effect on ion in spores germination, or accumulated on the surface of leaves and make physical obstacle can prevent the germ tube from penetration the leaves [29]. On the other hand, the result of [30] showed that (PS) 18 g/L and (PB) 10 g/L were active in controlling PM on cucumber caused by *Sphaerotheca fuliginea* percentage of disease control were 93, 100% respectively, also the results showed that both treatment were similar to Azoxystrobin fungicide.

**Table 3.** Effect of foliar spraying of chemical agents in percentage control of PM disease in Zucchini plantations in greenhouse conditions.

No.	Treatments	% control
1	PS 5g/L	68.17
2	PS 3g/L	77.26
3	SS 5g/L	67.52
4	SS 3g/L	77.65
5	PB 5g/L	94.80
6	PB 3g/L	77.54
7	MEGAVIL	99.35
8	Control	0
	LSD	* 14.722

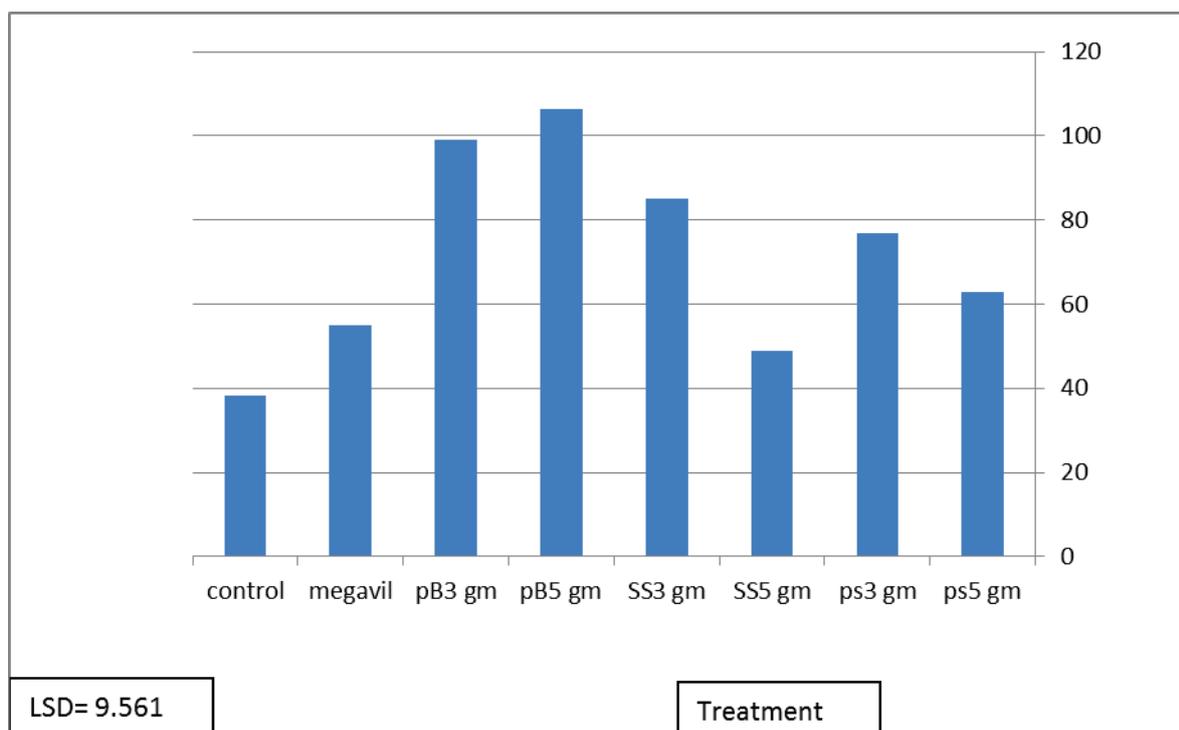
**3.4 Effect of foliar treatment of chemical compounds in total chlorophyll and leave area in zucchini plant und greenhouse conditions.**

The results of fig (1) referred that the total chlorophyll content was between 44.4 – 69.48. MEGAVIL treatment was the highest with chlorophyll content 69.48 followed by (PB) 5g/L and (PB) 3g/L with 60.08 and 66.4, no significant differences between (PS) 5g/L, (SS)

5g/L with 48.44 and 52.4 comparing with control 40.14. The results of fig (2) showed the leaves area for zucchini plants under greenhouse conditions were between 48.93–106.46. MEGAVIL treatment recorded highest value with 106.46 followed by (PB) 3g/L, (PB) 5g/L with 85.05 – 99.04 respectively, no significant differences between (SS) 5g/L, (PS) 5g/L, with 54.91 – 62.93 respectively, while the lowest value of leaves

area was in (SS) 3g/L with 48.93 comparing with control 38.04. All the results agreed with [31] who showed that relationship between treating the plant with (PB) and availability of some nutrient elements, also referred to the positive effect of (PB) in photosynthesis, accumulation of carbohydrates, and increasing the ability of plant to bear the drought. [32] reported about the important role of Bicarbonates in increasing the efficiency of chloroplast. PM disease on zucchini enhanced the leaves area, as the results

showed that the foliar treatment of (PB) can help the direct contact between (PB) and the pathogen, as a result of this study reduced the risk of PM and enhance the photosynthesis, and protein content and the productivity [33]. Other researches showed the positive effect of silicon in controlling PM through constricting the colonies and decrease the pathogen. The disease progress, increasing the dry weight of cucumber leaves and increasing the leaves area [34].



**Figure 1.** Effect of foliar treatment of chemical compounds in total Chlorophyll of Zucchini plants under greenhouse conditions.

### 3.5 Effect of foliar treatment of chemical compounds in the productivity of infected zucchini plants under greenhouse conditions.

The results showed that all treatments increased the yield of one plant comparing with control. The yield of one plant was between 1090 – 1410 g/ plant, while control was 618 g/ plant. No significant differences between MEGAVIL, (PB) 3g/L and (PB) 5g/L with 1340, 1380, and 1410 g/ plant respectively. Sodium Silicates (SS) 3g/L recorded increasing in the yield with 1300 g/ plant also it was better than (PS) 3g/L and (PS) 5g/L with 1150 – 1180 respectively, PM is considered one of an important disease on cucurbitaceae causing significant loss in production [35], it's one of the common disease on zucchini. The pathogen is attacking the leaves and stems, but not the fruits, during the

progress of disease the fruits can be damaged. and the productivity will decrease [36]. The decrease in productivity may be because of the effecting on photosynthesis or may be pollination seed, lost its activity, or the receptors on filament may be damaged. This agreed with [37], who referred that (PB) reduced disease severity of PM on zucchini and cucumber, and as a result increasing the productivity under the field conditions. [38] mentioned that there on toxic effects of (SS) 5g/L on the leaves of crape, on the other hand increasing the weight of cluster and increasing the fruits content of sugars. [27] found that treating watermelon leaves with (PS) led to reducing disease severity and increasing the biological age of the plant comparing with control.

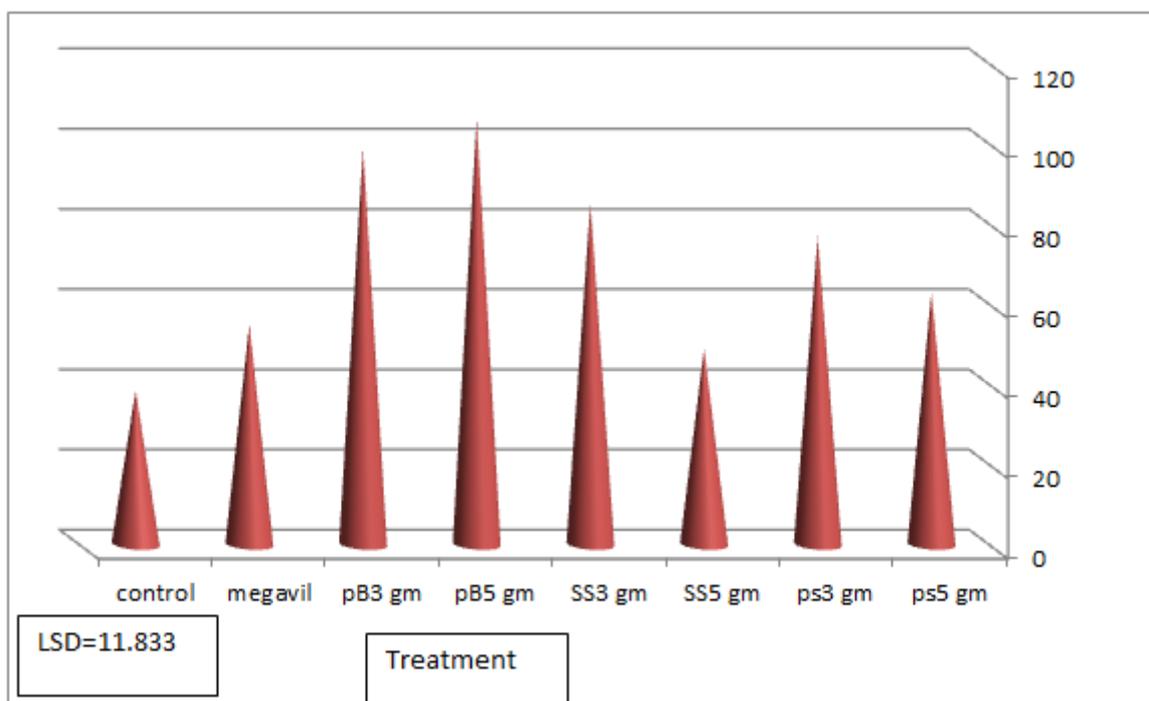


Figure 2. Effect of foliar treatment of chemical compounds in leaves area of Zucchini plants under greenhouse conditions.

### 3.6 The relationship between total productivity and total AUDPC.

The results of fig (3) refer to the relationship between the productivity and AUDPC. The highest value of AUDPC was in control, and the lowest value was in

MEGAVIL, while the highest total production was 1410 g/ plant in MEGAVIL treatment and the lowest in control with 618 g/ plant, so that there are reversal correlation between total AUDPC and the productivity, with correlation factor 0.11.

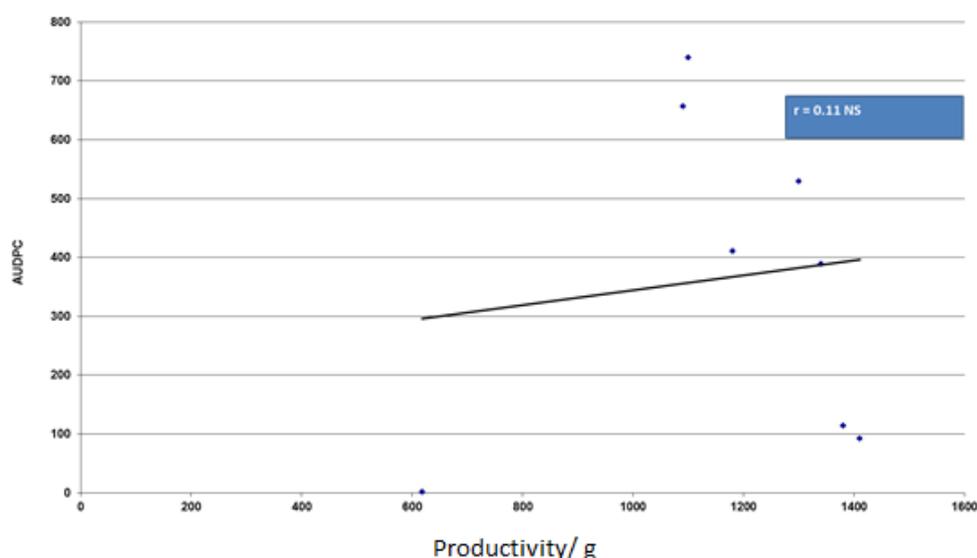


Figure 3: Relationship between total AUDPC and total productivity.

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