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# EFFECT OF FOLIAR APPLICATIONS OF GIBBERELLIC ACID, INDOLE ACETIC ACID AND SALICYLIC ACID ON FABA BEAN GROWTH, YIELD AND CHOCOLATE SPOT DISEASE SEVERITY

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**ABSTRACT:** *Field experiment was conducted at the two successive seasons 2011/2012 and2012/2013 to study the effect of salicylic acid (SA), gibberellic acid ($GA_3$) and indole acetic acid (IAA) singly (SA) or in combinations at the concentrations of $10^{-4}$, $10^{-5}$ and$10^{-6}$ M on faba bean, vegetative growth, yield components and some biochemical constituents in correlation with chocolate spot disease incidence. Foliar applications of $GA_3$ and SA+IAA at$10^{-5}$ M had significant effect in increasing plant height, fresh and dry weight of shoots in both seasons as compared with those of control. Moreover $GA_3$, IAA and SA+IAA at $10^{-5}$ M recorded the maximum responses in most parameters of both plant growth and yield components, i.e. plant height, number of branches/plant, number of pods/plant, number of seeds/plant, weight of seeds/plant 100-seed/weight and seed yield/fed. Generally, the contents of chlorophyll a, chlorophyll b and total chlorophyll, peroxidase activity and total phenol content were significantly the highest in response to the applications of SA, $GA_3$ and IAA singly or in combinations at $10^{-4}$ and$10^{-5}$ M, compared to nontreated control. Crude protein and total carbohydrates were increased significantly at $10^{-4}$ or $10^{-5}$ M. Application of IAA and SA+$GA_3$ at $10^{-5}$ M resulted the highest values of protein with the average of 26.38 and 25.88% and carbohydrate with the average of 56.85 and 58.32%, respectively. All treatments at the rate of $10^{-4}$ and $10^{-5}$ M significantly decreased chocolate spot disease severity and increased the yield components of faba bean compared with the untreated control plants. The maximum reduction of disease severity was obtained with Kocide 101 and SA+$GA_3$ followed by SA+IAA at $10^{-5}$ M with the average of 76.09, 71.74 and 64.13%, respectively in the first season. On the other hand, the same results were obtained with SA+IAA and SA at rate $10^{-5}$ M with an average of 18.0% in the second season. So it could be concluded that the used chemical compounds could resist the detrimental effects of Botrytis fabae on the plant growth and improve yield production.*

**Key words:** *Growth regulators, salicylic acid, faba bean, chocolate spot, peroxidase, total phenol.*

## INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the earliest domesticated legumes which represents a very important source of protein for the human diet, especially for poor section of the population in Egypt and/or for animal feed in several countries. However, this crop is subjected to many abiotic and biotic stresses that seriously compromise the final yield (Tivoli *et al.*, 1988 and Abdalla Abdalla and Darwish, 2002). Among the menacing stresses, chocolate spot disease caused by *Botrytis fabae* Sard. is one of the most economically important diseases that damages the plant foliage, limit photosynthesis activity, and reduces faba bean production globally (Torres *et al.*, 2004). For example, The subsequent loss was estimated to be more than 55% for susceptible cultivars (El-Bramawy and Abdul Wahid, 2007) and in other cases, losses were found to score approximately 100%., especially when favorable conditions prevail (Yi, 1986). Therefore, it is necessary to protect faba bean from this disease to cover the gap between production and consumption of this crop in Egypt.

At last few years, many great efforts were carried out to save the environment from pollution. Application of pesticides is considered one of the most famous environmental pollutants. Ryals and Ward (1994) mentioned that all plants have the ability to defend themselves against pathogenic infection through a wide variety of mechanisms that can be local or systemic, constitutive or inducible. Moreover, plant diseases are a major problem for agriculture worldwide, understanding the mechanisms employed by plants to defend themselves against pathogens may lead to novel strategies to enhance disease resistance in crop plants (Pozo *et al.*, 2005).

The systemic acquired resistance (SAR) is a pathogen inducible defense mechanism that dependent on salicylic acid (SA) and is associated with a system expression of a subset of defense gene, e.g. the acidic proteins (Ward *et al.,* 1991). Oostendorp *et al.* (2001) revealed that the best-characterized signal pathway for systemically induced resistance is SAR that is activated by localized infections with necrotizing pathogen. It is characterized by protection against a broad range of pathogens through formation of set of induced proteins and its dependence of salicylic acid. Salicylic acid (SA) was reported as plant resistance inducer in many plants represents an interesting new opportunity in controlling fungal and bacterial diseases within environmental friendly integrated crop protection system through enhancing of plant to pathogen ( Hassan *et al* 2006, Rajkumar *et al.*, 2008; Wang *et al.*, 2010 and Yehia, *et al.*, 2011). Salicylic acid showed synergetic effect with auxin and gibberellins (Sanaa *et al.*, 2006). Moreover, in a number of species SA promoted flowering in combination with other plant growth regulators such as kinetin, indole acetic acid and gibberellins (Shehata, *et al.*, 2000).

The regulation of plant growth and biosynthesis of important economic constituents could be achieved through plant growth regulators. Applying growth regulators may modify morphological and physiological characteristic of plant and may induce better adaptation of plants to the environment, which could improve the growth and yield. The use of plant growth regulators are directed, in general, to improve the yield quality and/or quantity of many crop (Rabie 1996). Gibberellic acid ($GA_3$) and benzyladenine (BA) are the most important natural growth regulators in use. They are used to induce great changes in the growth regulators characters, chemical composition and yield criteria of *Hibiscus sabdariffa* L. In this concern, Nowak *et al.* (1997), Ramadan (1998) and Ibrahim *et al.* (2007) reported that $GA_3$ and (BA) treatments increased *Vicia faba* yield components. Foliar application of IAA also increased plant height, number of leaves /plant, fruit size with consequent enhancement in seed yield in different crop like groundnut (Lee, 1990), and cowpea ( Khalil and Mandurah, 1989). Gaber *et al.* (2000) reported that foliar spray of faba bean with $GA_3$ increased the polysaccharides which form the predominant fraction in the carbohydrate pool in the yielded seeds and thereby increased significantly the total carbohydrates.

Growth regulators ($GR_S$) are generally used in commercial farming to direct the plant growth in particular dimension. Plant pathogens also disturb the balance of these growth vitals and cause abnormal growth. Although $GR_S$, e.g. prohexandione-Ca are inactive with respect to pesticides (Rademacher and Bucci, 2002), it had been reported that plants do not only show better growth under the action of growth regulators but also show reduced occurrence of the disease (Costa *et al.,* 2001; Maxson and Jones, 2002 and Roemmelt *et al.*, 2003).

Hopkins (1985) mentioned that foliar application of indole acetic acid (IAA) at 200 mg/ml and kinetin at 1.000 mg/ml on *vitid rotundifolia* (Carlos) showed moderately resistant to pierces 's disease (PD), prevented the development of PD symptoms in inoculated plants in the greenhouse. These treatments also prevented accumulation of PD bacteria in leaves of the plants. El- korashy (1998) found that spraying growth regulators ($GA_3$), naphthalene actic acid (NAA) and indole acetic acid (IAA) reduced the incidence of soil borne diseases, pod rot and increased peanut yield. Indol acetic acid (IAA) showed best prevention in case of pre and post emergence damping-off (Shafique *et al.*, 2011), followed by Indole butyric acid (IBA). Bazzi *et al.* (2003a and 2003b) investigated bacterial wilts and downy mildews of different crop plants and reported that application of $GR_S$ is also a beneficially preventive measure against them. Halbwirth *et al.*, (2003) concluded that use of growth regulators might be a considerable alternative of antibiotics against bacterial blights. El-Desouky (2006) reported that treating cucumber plants with plant growth regulators Ethephan, cycocyl, terpal and morphactin reduced disease severity of powdery and downy mildew and consequently increased protection of different cucumber cultivars under both greenhouse and field conditions.

The objective of this research was to determine the efficacy of the commercial inducer resistance of salicylic acid (SA) and plant growth regulators gibberellic acid ($GA_3$) and indole acetic acid (IAA) singly or in combinations with (SA) to reduced the faba bean chocolate spot disease under field conditions and evaluating the enhancement of growth and seed yield plants. In addition, estimation of some associated biochemical changes in treated plants were studied.

## MATERIALS AND METHODS

Field experiments were carried out at Etay- El-Baroud Agric. Res. Station during the seasons 2011-2012 and 2012-2013 in randomized complete blocks design with three replicates. Experimental plot ($5.4m^2$) had two ridges, 60 cm in between, and 3 meters long. Planting took place at the recommended in two sides/ridge with 2 seeds per hill; 20 cm apart which had been sown on 13 November of both seasons. Faba bean cultivar Giza 2 was used in this investigation, which obtained from Legumes Research Section, Field Crops Research Institute, Agricultural Research Center, Giza, Egypt. All agricultural practices were carried out according to the recommendations of Ministry of Agriculture, Egypt. In both seasons, foliar application of the growth regulators used were conducted, *i.e.*, gibberellic acid ($GA_3$) and indole acietic acid (IAA) besides the growth inducer of salicylic acid (SA), supplied from Sigma Chemical Company, and used at $10^{-4}$, $10^{-5}$ and $10^{-6}$ M concentrations and tap water as negative control. They were freshly prepared solutions, which sprayed after 30, 45 and 60 days after sowing. The surfactant super film 0.3%, was added to the prepared solutions before using and kocide 101 at 2.5 g/L as fungicide against chocolate spot disease and used as positive control.

The tested treatments were:

1- $10^{-4}$, $10^{-5}$ and $10^{-6}$ M (SA)
2- $10^{-4}$, $10^{-5}$ and $10^{-6}$ M ($GA_3$)
3- $10^{-4}$, $10^{-5}$ and $10^{-6}$ M (IAA)
4- $10^{-4}$ M (SA + $GA_3$)
5- $10^{-5}$ M (SA + $GA_3$)
6- $10^{-6}$ M (SA + $GA_3$)
7- $10^{-4}$ M (SA + IAA)
8 - $10^{-5}$ M (SA + IAA)
9 - $10^{-6}$ M (SA + IAA)
10 - Tab water as negative control.
11- kocide 101 at 2.5g/L positive control.

### Growth parameters:

Five plants were randomly chosen from the center row of each plot at 90 days after sowing in both seasons to estimate plant height (cm), fresh and dry weight of shoots/plant (g).

### Yield and its components:

After physiological maturity about 170 days after sowing, five plants from each plot were harvested at random to determine plant height (cm); number of pods/plant; number of seeds/plant; weight of seeds/plant, number of branches/plant and weight of 100-seeds (g).

### Disease assessment:

The disease severity of chocolate spot was estimated after 55 and 75 days from sowing under natural infection conditions. Twenty plants were selected randomly from each plot using a 0-9 scale, where 0, 1, 2, 3, 4, 5, 6, 7 and 8 represent no visible infection (0) or disease covering less than 10%, 20%, 30%, 40%, 50%, 60% 70% or 80% of foliar tissue, respectively and 9 represents disease covering more than 80% of the foliar tissue. Disease severity (DS) values were calculated using the following formula, according to Wheeler (1969) and ICARDA, (1986):

DS(%)= isease grade x number of plant in each grade)
(total number of plants x highest disease grade)

## Chemical analysis:

### Estimation of photosynthetic pigments:

Chlorophyll a, b and chlorophyll a+b were determined quantitatively using N, N-dimethyliformamide (DMF) as described by (Mortan and Porath1980). Leaves were selected from different positions on the stem. Fresh weight samples were taken after 90 days after sowing and immersed directly in pure DMF {2-5% w/v}, then kept in the dark for 1-2 days at 4C°. The extracts were centrifuged for 15 minutes at 3000 rpm, and then the supernatant was diluted to the appropriate volume. Thereafter, the extinction of the extracts were measured photometrically (Uvnis Spectrophotometer, Lambda 2, Perkin-Elmer and Co. GmbH, 8027, F.R.G.) against a blank of pure DMF at 646.8, 663.8 and 750 nm.

The following equations were applied for determining the Chl content (mg/ml) of the leaf sample:

Chl a= 12.00 ($E_{663.8} - E_{750}$) - 3.11 ($E_{646.8} - E_{750}$)
Chl b= 20.78 ($E_{646.8} - E_{750}$) - 4.88 ($E_{663.8} - E_{750}$)
Chl a+b = 17.67 ($E_{646.8} - E_{750}$) +7.12($E_{663.8} - E_{750}$)
The Ch1 content was then expressed as mg/g f. wt.

### Determination of peroxidase and total phenol content:

The activity of peroxidase enzyme was determined by employing the method of Thimmaiah (1999), after 90 days from sowing, 3 g fresh leaves were ground in a precooled mortar and pestle containing 9 ml of 0.1 M phosphate buffer (pH 7.1). The extract was centrifuged at 3000 rpm at 6 C° for 20 min. Peroxidase activity was expressed as changes in absorbance $min^{-1}$ at 425 nm.

Total soluble phenols in fresh leaves (90 days age) were determined using the colorimetric method described by Folin and Ciocalteau (AOAC 1985).

### Determination of carbohydrate and total protein:

Total carbohydrate was determined in the dried seeds using phenol sulphuric method (Dubois *et al.,* 1956). Total nitrogen percentage was determined by micro-kjeldal method as described by A.O.A.C. (1975), and the percentage of protein was calculated by multiplying total N by factor 6.25.

### Statistical analyses:

Data obtained were subjected to the statistical analysis according to the standard methods recommended by (Gomez and Gomez, 1984) using the computer program (costate). Means were compared using L.S.D. at the level 5% of probability.

## RESULTS AND DISCUSSION

Data present in Table (1) show the effect of foliar application of SA, $GA_3$ and IAA at $10^{-4}$ $10^{-5}$ and $10^{-6}$M singly or in combinations on plant height, fresh and dry weights of faba bean shoots after 90 days after sowing. Generally, application of the tested compounds led to significant differences between these treatments in both seasons. In the first season, the highest values of plant height were obtained from the application of SA+IAA at $10^{-5}$ M with an average of 89.40 cm compared to control followed by $GA_3$, SA+$GA_3$ and SA at the rate of $10^{-5}$ with average of 87.40, 87.40 and 84.60 cm, respectively. However, kocide 101 had similar value obtained from the application of SA at $10^{-4}$ and $10^{-6}$ M with an average of 78.60 cm for them. In the second season, $GA_3$, SA+IAA and IAA at $10^{-5}$ M increased plant height and their averages were 89.80, 88.80 and 87.80 cm, respectively. Marschner (1986) indicated that application of $GA_3$ or IAA caused elongation in the primary plant cells in the young tissues and growth centers. In this respect, other investigators reported that faba bean plant height was increased due to foliar application of $GA_3$ or IAA (Shalaby and Ahmed 1994 and Abdel-Fattah 1997). Also, Bekheta (2004) reported that foliar application of $GA_3$, on wheat plants increased plant height.

**Table (1). Effect of foliar spray of SA, $GA_3$, IAA singly or in combinations on faba bean plant growth parameters after 90 days from sowing, under field conditions.**

| Treatment \ Growth parameter | 2011/2012 | | | 2012/2013 | | |
|---|---|---|---|---|---|---|
| | Plant height (cm) | Fresh weight (g) | Dry weight (g) | Plant height (cm) | Fresh weight (g) | Dry weight (g) |
| $10^{-4}$ M SA | 78.60 | 67.85 | 10.38 | 76.00 | 77.72 | 9.61 |
| $10^{-5}$ M SA | 84.60 | 76.52 | 11.59 | 78.20 | 81.12 | 11.37 |
| $10^{-6}$ M SA | 78.60 | 59.87 | 9.16 | 69.40 | 70.23 | 8.81 |
| $10^{-4}$ M $GA_3$ | 82.20 | 78.88 | 12.79 | 84.80 | 78.45 | 11.05 |
| $10^{-5}$ M $GA_3$ | 87.40 | 91.73 | 16.47 | 89.80 | 92.24 | 12.99 |
| $10^{-6}$ M $GA_3$ | 72.80 | 74.21 | 12.46 | 81.60 | 77.07 | 10.31 |
| $10^{-4}$ M IAA | 81.00 | 80.84 | 12.87 | 84.20 | 84.58 | 10.48 |
| $10^{-5}$ M IAA | 87.40 | 79.73 | 13.58 | 87.80 | 93.62 | 12.18 |
| $10^{-6}$ M IAA | 79.40 | 71.33 | 10.90 | 75.60 | 76.35 | 10.27 |
| 10-$^4$M SA+ $GA_3$ | 80.40 | 69.04 | 11.17 | 77.60 | 70.15 | 9.71 |
| $10^{-5}$ M SA+ $GA_3$ | 87.40 | 68.82 | 9.91 | 81.00 | 71.34 | 10.34 |
| 10-$^6$ M SA+ $GA_3$ | 82.00 | 58.40 | 9.18 | 75.20 | 62.08 | 9.19 |
| $10^{-4}$ M SA+IAA | 79.40 | 87.25 | 13.15 | 76.20 | 81.77 | 8.46 |
| $10^{-5}$ M SA+IAA | 89.40 | 80.85 | 13.60 | 88.80 | 81.49 | 11.16 |
| $10^{-6}$ M SA+IAA | 77.60 | 63.86 | 10.14 | 76.20 | 69.57 | 8.46 |
| Kocide 101 | 78.60 | 64.17 | 9.54 | 74.00 | 65.69 | 9.02 |
| Control | 75.80 | 61.13 | 9.36 | 72.20 | 64.35 | 8..03 |
| LSD at 5% | 8.62 | 16.06 | 2.95 | 7.40 | 14.48 | 2.49 |

Generally, fresh weight of shoots was increased significantly in plants sprayed with SA, $GA_3$ and IAA singly or in combinations of (SA+$GA_3$) and (SA+IAA). In the first season, the best results were obtained with $GA_3$ at $10^{-5}$ M and (SA+IAA) at 10-$^4$ M with the average of 91.73 and 87.25 g, respectively. On the contrary, the lowest values were obtained with (SA+ $GA_3$) and SA at $10^{-6}$ M with the average of 58.40 and 59.87 g, respectively compared to all treatments. In the second season significant increases were clear in the fresh weight of plants sprayed with IAA and $GA_3$ at $10^{-5}$ M with the average of 93.62 and 92.24 g., respectively, followed by IAA at$10^{-4}$ M and SA+IAA at$10^{-4}$ or $10^{-5}$ M with the average of 84.58, 81.49 and 81.77 g, respectively.

Dry weight of faba bean shoots was significantly differed according to variable treatments. However, $GA_3$ at$10^{-5}$M resulted the highest shoot dry weight at both seasons (16.47 and 12.99 g), respectively. Also, the concentrations of $10^{-4}$ M (SA+IAA), $10^{-5}$ M (IAA) and $10^{-4}$ M (SA+IAA) gave the average of 13.60, 13.58 and 13.15 g, respectively in the first season. However, in the second season the best values obtained with $10^{-5}$ M ($GA_3$) followed by $10^{-5}$ M (IAA) and $10^{-5}$(SA) with the average of 12.99, 12.18 and 11.37 g, respectively. Abdel-Latef (2003) and Abdel-Latef *et al.* (2009) reported that the increase in dry matter due to soaking in $GA_3$ and IAA solution might be attributed to rapid increase in cell division, cell enlargement and accumulation of building units that accompanied by greater saccharides content than those of untreated plants

Data recorded in Table (2) clear that spraying faba bean plants with SA, $GA_3$ and

IAA either singly or in combinations caused marked effect on plant height, number of branches/plant, number of pods/plant; number of seeds/plant; weight of seeds/plant, 100-seeds/weight and seed yield/fed. in comparison with the untreated control plants. The highest values of plant height were achieved when $10^{-4}$ and $10^{-5}$ M (IAA) and $10^{-4}$ M ($GA_3$) were applied, followed by SA+ $GA_3$ at$10^{-5}$ M with the average of 112.4, 112.0, 108.6 and 108.0 cm, respectively. About the number of branchs /plant also $GA_3$ at $10^{-4}$ and $10^{-5}$ M had the best values with the average of 6.8 and 6.4, respectively. Sarkar *et al.* (2006) found that $GA_3$ and IAA had regulatory effect to enhance plant height, number of branches, compared to other plant growth regulators and control. The highest number of pods/ plant was clear in case of $10^{-4}$M ($GA_3$) and $10^{-5}$ M (SA+$GA_3$) with the average of 32.00 and 30.00, respectively. In the case of number of seeds/plant, $10^{-4}$ M ($GA_3$) and $10^{-5}$ M (IAA) recorded the best values with the average of 87.00 and 85.80, respectively and the same trend was clear in case of seeds weight/plant with the average of 59.09 and 56.89 g, respectively. Both treatments of $GA_3$ and SA+ $GA_3$ at $10^{-5}$ M increased 100-seed weight with the average of 76.81 and 76.18 g, respectively. Finally, from the same table it is clear that, seed yield/fed. was in harmony with the weight of seeds/plant especially in case of $10^{-4}$ M ($GA_3$), $10^{-5}$ M (IAA), $10^{-4}$ M (SA+$GA_3$) and IAA at $10^{-4}$M with the average of 3.22, 3.14, 3.09 and 3.00 (ton), respectively. Ibrahim *et al.* (2007) illustrate that the increase in the yield could be reflection of bioregulators effect on growth and development, it might be due to a) marked increase in the number of branches/plant which gave a chance to the plant to carry more flowers, pods and hence more seeds b) marked increase in the phytosynthetic pigments content, which could lead to increase in phytosynthesis, resulting in greater transfer of assimilates to seeds causing increase in their weight (Table,4).

Table (3) shows the results of the second growing season where significant increase in plant height was noticed when any of $GA_3$, IAA and SA+$GA_3$ at $10^{-5}$ M was applied compared to the untreated plants (control) with the average of 112.6, 111.6 and 110.0 cm, respectively. Gibberellic acid was also reported to increase plant height, number of leaves and total plant weight of *Hibiscus sabdariffa* L. (Mukhtar, 2008) .On the other hand, the differences in the number of branches/plant were not significant during second season. These results are supported by the findings of Ibrahim *et al.* (2007) who reported that the differences in the number of branches/plant due to application of benzyl adenine, ancymidol or IAA were not significant at all studied growth stages during two seasons. Number of pods/plant was increased significantly in plants sprayed with $10^{-5}$ M (IAA and SA+ $GA_3$) and $10^{-4}$ M (SA+IAA) with the average of 32.80, 31.20 and 30.80 pod/plant, respectively. Significant increase in number of seeds/plant cleared with the application of $10^{-5}$ and $10^{-4}$ M (IAA), $10^{-5}$ M (SA+ IAA) and $10^{-4}$ M ($GA_3$) with the average of 88.00, 87.40, 85.20 and 85.00 g, respectively. The highest 100-seeds weight was found in the cases of $10^{-5}$M ($GA_3$), SA+ $GA_3$ at $10^{-4}$M and $10^{-5}$ M (IAA) with the average of 70.43, 69.20 and 67.02 g., respectively. (Asharf *et al.*, 2006) concluded that IAA is successful in enhancing the plant growth and yield of barley cultivars. The highest values of yield/fed (ton) were obtained by using $10^{-5}$ or $10^{-4}$ M (IAA) and SA+IAA at $10^{-5}$ M with the average of 3.12, 3.10 and 3.03 (ton), respectively. The increment of the above agronomic characters is in agreement with the findings of Mostafa *et al.* (2005) and Nair *et al.* (2002) who, found that the increase in seed yield of roselle plants by application of $GA_3$ and /or benzyladenine (BA) relative to untreated plants might be result a through breaking the apical dominate of rosella plants which led to increase both flowers and branches and consequently the number of fruits. The increase in seed weights might be ascribed to the promotive effect of $GA_3$ and BA in increasing the assimilates and their translocations from leaves to the fruits.

**Table (2). Effect of foliar spray of SA, $GA_3$ and IAA singly or in combinations on yield components of faba bean plants after 170 days from sowing grown under field conditions during first season.**

| Yield component / Treatment | Plant height (cm) | No. of branches /plant | No. of pods per plant | No. of seeds per plant | Weight of seeds/plant (g) | 100-seeds weight (g) | Seed yield per fed. (ton) |
|---|---|---|---|---|---|---|---|
| $10^{-4}$ M SA | 89.80 | 5.8 | 21.00 | 70.00 | 43.45 | 66.53 | 2.95 |
| $10^{-5}$ M SA | 96.40 | 6.0 | 29.20 | 79.60 | 46.74 | 68.42 | 2.86 |
| $10^{-6}$ M SA | 89.80 | 5.2 | 21.00 | 62.20 | 37.49 | 64.30 | 2.16 |
| $10^{-4}$ M $GA_3$ | 108.6 | 6.8 | 32.00 | 87.00 | 59.09 | 68.27 | 3.22 |
| $10^{-5}$ M $GA_3$ | 106.8 | 6.4 | 26.80 | 83.80 | 54.72 | 76.81 | 3.09 |
| $10^{-6}$ M $GA_3$ | 104.0 | 6.4 | 24.00 | 64.60 | 35.73 | 60.17 | 2.41 |
| $10^{-4}$ M IAA | 112.4 | 6.4 | 29.80 | 79.00 | 51.47 | 63.56 | 3.00 |
| $10^{-5}$ M IAA | 112.0 | 6.0 | 29.20 | 85.80 | 56.89 | 67.16 | 3.14 |
| $10^{-6}$ M IAA | 104.6 | 5.4 | 24.80 | 77.80 | 48.86 | 60.20 | 2.91 |
| $10^{-4}$M SA+ $GA_3$ | 105.0 | 5.8 | 26.00 | 75.00 | 55.51 | 66.99 | 3.09 |
| $10^{-5}$ M SA+ $GA_3$ | 108.0 | 6.4 | 30.00 | 84.40 | 49.57 | 76.18 | 2.95 |
| $10^{-6}$ M SA+ $GA_3$ | 95.20 | 5.8 | 22.00 | 63.00 | 30.24 | 63.95 | 2.80 |
| $10^{-4}$ M SA+IAA | 103.4 | 5.2 | 21.20 | 80.00 | 44.32 | 68.71 | 2.97 |
| $10^{-5}$ M SA+IAA | 104.0 | 5.4 | 24.60 | 83.00 | 47.35 | 71.00 | 2.98 |
| $10^{-6}$ M SA+IAA | 103.2 | 4.6 | 22.40 | 64.40 | 42.61 | 66.99 | 2.89 |
| Kocide 101 | 94.80 | 6.2 | 26.00 | 73.80 | 53.66 | 65.13 | 2.95 |
| Control | 94.20 | 4.4 | 20.20 | 58.60 | 34.97 | 59.46 | 2.41 |
| LSD at 5% | 9.65 | 0.913 | 7.03 | 14.82 | 13.30 | 3.63 | 0.52 |

**Table (3). Effect of foliar spray of SA, $GA_3$ and IAA singly or in combinations on yield components of faba bean plants after 170 days from sowing grown under field conditions during second season.**

| Yield component / Treatment | Plant height (cm) | No. of branches /plant | No. of pods per plant | No. of seeds per plant | Weight of seeds/plant (g) | 100-seeds weight (g) | Seed yield per fed. (ton) |
|---|---|---|---|---|---|---|---|
| $10^{-4}$ M SA | 97.00 | 5.0 | 28.20 | 74.60 | 48.49 | 62.14 | 2.96 |
| $10^{-5}$ M SA | 97.00 | 5.2 | 28.20 | 80.80 | 51.52 | 65.46 | 2.87 |
| $10^{-6}$ M SA | 89.00 | 4.8 | 23.20 | 66.60 | 41.06 | 62.53 | 2.14 |
| $10^{-4}$ M $GA_3$ | 108.8 | 5.8 | 30.00 | 85.00 | 60.35 | 65.31 | 3.03 |
| $10^{-5}$ M $GA_3$ | 112.6 | 5.4 | 29.40 | 80.00 | 57.82 | 70.43 | 300 |
| $10^{-6}$ M $GA_3$ | 106.2 | 5.4 | 25.40 | 67.40 | 43.58 | 61.67 | 2.23 |
| $10^{-4}$ M IAA | 108.4 | 5.6 | 29.60 | 87.40 | 62.04 | 62.62 | 3.10 |
| $10^{-5}$ M IAA | 111.6 | 5.6 | 32.80 | 88.00 | 65.47 | 67.02 | 3.12 |
| $10^{-6}$ M IAA | 105 | 5.2 | 26.00 | 66.60 | 50.55 | 59.68 | 2.59 |
| $10^{-4}$M SA+ $GA_3$ | 104 | 4.8 | 29.00 | 70.00 | 51.85 | 69.20 | 2.94 |
| $10^{-5}$ M SA+ $GA_3$ | 110 | 5.2 | 31.20 | 81.00 | 47.31 | 67.00 | 3.02 |
| $10^{-6}$ M SA+ $GA_3$ | 99.00 | 4.8 | 25.00 | 71.80 | 31.19 | 62.14 | 2.46 |
| $10^{-4}$ M SA+IAA | 103 | 4.8 | 28.80 | 79.80 | 52.17 | 64.24 | 2.79 |
| $10^{-5}$ M SA+IAA | 108.2 | 5.0 | 30.80 | 85.20 | 60.56 | 66.33 | 3.03 |
| $10^{-6}$ M SA+IAA | 102 | 4.4 | 20.20 | 69.20 | 46.87 | 63.61 | 2.88 |
| Kocide 101 | 95.2 | 5.2 | 27.20 | 72.80 | 56.23 | 62.21 | 2.74 |
| Control | 95.2 | 4.8 | 22.80 | 64.00 | 48.39 | 60.70 | 2.37 |
| LSD at 5% | 7.41 | ns | 5.98 | 14.58 | 8.38 | 4.96 | 0.56 |

**Table (4). Effect of foliar spray of SA, $GA_3$ and IAA singly or in combinations on chlorophyll a,b and total chlorophyll as mg/g leaves of faba bean during two seasons.**

| Treatment | (2011/2012) | | | (2012/2013) | | |
|---|---|---|---|---|---|---|
| | Chl. (a) | Chl. (b) | Chl. (a+b) | Chl. (a) | Chl. (b) | Chl. (a+b) |
| $10^{-4}$ M | 1.03 | 0.52 | 1.55 | 0.94 | 0.47 | 1.41 |
| $10^{-5}$ M SA | 1.10 | 0.49 | 1.60 | 0.98 | 0.53 | 1.51 |
| $10^{-6}$ M | 0.91 | 0.52 | 1.43 | 0.95 | 0.42 | 1.37 |
| $10^{-4}$ M | 1.30 | 0.67 | 1.97 | 0.96 | 0.45 | 1.41 |
| $10^{-5}$ M $GA_3$ | 1.22 | 0.59 | 1.81 | 0.98 | 0.49 | 1.47 |
| $10^{-6}$ M | 1.05 | 0.44 | 1.49 | 0.95 | 0.43 | 1.38 |
| $10^{-4}$ M | 0.98 | 0.51 | 1.49 | 0.98 | 0.45 | 1.39 |
| $10^{-5}$ M IAA | 1.27 | 0.66 | 1.96 | 0.96 | 0.47 | 1.45 |
| $10^{-6}$ M | 0.94 | 0.50 | 1.44 | 0.96 | 0.43 | 1.38 |
| 10-$^{4}$M | 1.14 | 0.49 | 1.63 | 0.97 | 0.46 | 1.43 |
| $10^{-5}$ M SA+ $GA_3$ | 1.25 | 0.60 | 1.85 | 0.95 | 0.51 | 1.46 |
| 10-$^{6}$ M | 1.06 | 0.50 | 1.56 | 0.96 | 0.44 | 1.40 |
| $10^{-4}$ M | 0.96 | 0.59 | 1.55 | 0.95 | 0.40 | 1.35 |
| $10^{-5}$ M SA+IAA | 1.09 | 0.55 | 1.64 | 0.98 | 0.49 | 1.47 |
| $10^{-6}$ M | 0.99 | 0.53 | 1.52 | 0.94 | 0.34 | 1.28 |
| Kocide 101 | 0.98 | 0.59 | 1.57 | 0.96 | 0.46 | 1.42 |
| Control | 0.95 | 0.50 | 1.45 | 0.95 | 0.43 | 1.38 |
| LSD at 5% | 0.11 | 0.04 | 0.14 | ns | 0.05 | ns |

Data recorded in Table (4) indicate that spraying faba bean plants in the first season (2011/2012) with SA, $GA_3$, and IAA at $10^{-4}$ or $10^{-5}$ M singly or in combinations caused significant increase in photosynthetic pigments content (chlorophyll a, chlorophyll b and chl. a+b) in the leaves of faba bean plants collected after 90 days from sowing. The data revealed that foliar application of $10^{-4}$ M ($GA_3$), IAA at $10^{-5}$ M and/or SA+ $GA_3$ at $10^{-4}$ M were more effective on the content of total chlorophyll than other treatments. The present results are in agreement with the findings of Ibrahim *et al.* (2007) who reported that spraying faba bean plants with $GA_3$, IAA and BA caused significant increase in the photosynthetic pigments content (chlorophy a, chlorophy b and chl. a+b) at 90 days after sowing. In the second season, photosynthetic pigments content Chl. a and Chl. a+b were not significantly affected with the studied treatments. On the other hand, significant increase in Chl. b obtained with SA, SA+$GA_3$, SA+IAA and $GA_3$ at $10^{-5}$ M. The increase in chlorophyll biosynthesis and inhibition of chlorophyllase enzyme leading to higher accumulation of chlorophyll (Paricha *et al.*, 1977 and Sivakumar *et al.*, 2002).

Generally, foliar application of SA, $GA_3$ and IAA significantly increased both protein and total carbohydrate contents of faba bean except in the case of SA at $10^{-4}$ and$10^{-6}$ M and $GA_3$ at $10^{-6}$M. (Table, 5). Seeds produced from the plants sprayed with IAA at $10^{-5}$ M and SA+ $GA_3$ at $10^{-5}$ or $10^{-4}$ M possessed the highest values of protein percentages with the average of 26.38, 25.88, 24.94 and 24.44, respectively. Total carbohydrate percentages were increased in the cases of $10^{-5}$, $10^{-4}$ M (SA+$GA_3$), $10^{-5}$ M (IAA) and $10^{-5}$, $10^{-4}$ M (SA+IAA) with the average of 58.32, 57.70, 56.85 56.25 and 55.24, respectively. Similar results were obtained by El-Etr, (2000) and Bardisi (2004) who found that application of kinetin on soybean and pea plants caused increase in seed protein and carbohydrate contents. Amin *et al.* (2006), also found that individual application of morphactin and indole-3-butric acid IBA at (25-100 mg) caused increase in carbohydrates and protein contents of maize grains as compared to their control. Similarly, Brnce (1990) and Chhun *et al.* (2004) showed that the highest values of carbohydrate and crude protein contents of *Oryza sativa* grains and soybean seeds were obtained.

Data present in Table (5) clear that faba bean foliar treatments with SA, $GA_3$ and IAA at $10^{-4}$ or $10^{-5}$ M singly or in combinations significantly increased the activity of peroxidase compared to the control treatment. In addition, foliar treatments of SA+$GA_3$, SA+ IAA and SA at $10^{-5}$ M recorded the highest increase in peroxidase activity compared to other treatments with the average of 0.785, 0.702, and 0.678 mg/g leaves, respectively. The results obtained in this study are confirmed with those mentioned by El-Fiki *et al.* (2007) in the case of sugar beet leaves infected by *Uromyces beta* and they point out the role played by catalse, peroxidase and polyphenoloxidase which are implicated in defensive mechanisms of host plant against the fungal pathogen; the results also are similar to the findings of Rodica (2012) who reported that peroxidase and polyphenoloxidase activities were found higher in the diseased leaves attacked by *Taphrina deformans* when compared to the enzymes activity of healthy leaves. This study suggests that the accumulation of reactive oxygen species in peach tissues, increase activities of such enzymes being involved in host defence mechanisms. Also, foliar application with SA and SA+IAA at $10^{-5}$ M resulted the highest increase in total phenol content (0.390 mg/g f.w.) respectively, followed by SA+$GA_3$ and SA at $10^{-4}$ M with the average of 0.380 and 0.360 mg/g f.w., respectively. Gozzo (2004) reported that salicylic acid might interact with iron-based enzymes, either as a cheletor of metal ion or though binding to related proteins. The plants forming phenolic free radicals, resulting from the interaction with catalase or peroxidase has proposed to be involved in the induction of systemic acquired resistance (SAR). These results are in agreement with the El-Nagar (1998) who indicated that the phenolic compounds, especially total phenols were more increased in the stem rust infected wheat plants pretreated with different concentrations of $GA_3$, as compared with the infected-untreated plants. Also, Chowdhury (2003) found that auxin led to increase in total phenol, calcium content and activity of catechol oxidase, and mentioned that these materials protect plants against pathogen stress. Wasternack *et al.* (2006) concluded that phenomenon of SAR has been found to be mediated by salicylic acid following the observation that exogenous treatment with salicylic acid induced PR-protein synthesis and enhanced resistance to infections. The expression of defense related protein (PR) are peroxidases, polyphenol oxidase etc. which are plant specific and released by pathogen in response to elicitors.

The effect of different treatments on chocolate spot disease severity (DS) and consequently protection of faba bean (Giza 2 cv.) during the two seasons 2011/2012 and 2012/2013 were shown in Table (6). All the treatments, salicylic acid (SA), gibberellic acid ($GA_3$) and indole acetic acid (IAA) at $10^{-4}$ $10^{-5}$ and $10^{-6}$ M either separately or in combinations significantly decreased the (DS) of chocolate spot during the two seasons under natural infection conditions. Kocide 101 had the best effect in reducing the disease severity followed by $10^{-5}$ M (SA+ $GA_3$ ) with disease reduction averages of 76.09 and 71.74% then $10^{-4}$M (SA+$GA_3$) and SA+IAA at $10^{-5}$ M with the average of 67.39 and 64.13%, respectively. Saswati *et al.* (1988) found that, the pretreated rice plants with $GA_3$ exhibited induced resistance to rice sheath rot disease. The obtained results are in harmony with the finding of El-Fiki *et al.* (2007) who mentioned that spraying plants of sugar beets with any of IAA, NAA and $GA_3$ was significantly effective for suppressing natural rust infection in sugar beet during 2000 and 2001. They also reported that spraying with IAA was the most effective followed by NAA and $GA_3$ compared with control. In this respect, the highest reduction was recorded in the second season with Kocide 101 followed by $10^{-5}$ M (SA and SA+IAA) with the averages of 71.43, 63.27 and 63.27% disease reduction, respectively. Indol acetic acid (IAA) showed best prevention results in case of pre and post emergence damping-off (Ragab *et al.*, 2009), followed by Indole butric acid (IBA) which provided second best prevention under identical circumstances. Salicylic acid plays a control role in the activation of defense responses against biotrophic and semi-biotrophic pathogens as well as the establishment of systemic resistance (Vlot *et al.*, 2009 Peleg and Blumwald, 2011). The phytohormones affect all phases of the plant life cycle and their responses to environmental stresses, both biotic and abiotic. (Williams, 2010). These results are in agreement with the findings of El-Korashy (1998) who found that spraying growth regulators gibberellin ($GA_3$), naphalene acetic acid (NAA) and indole acetic acid (IAA) on peanut plants reduced the incidence of soil borne disease, pod rot and increased as well; the yield.

**Table (5). Protein, total carbohydrate contents of produced seeds, peroxidase activity and total phenols content as mg/g leaves of faba bean plants sprayed with SA, $GA_3$ and IAA singly or in combinations (2011/2012).**

| Treatment | Protein % | Total Carbohydrate % | Peroxidase activity(Po) A424/min | Total phenols mg/g/f.w. |
|---|---|---|---|---|
| $10^{-4}$ M | 19.75 | 44.01 | 0.551 | 0.360 |
| $10^{-5}$ M SA | 24.19 | 51.45 | 0.678 | 0.390 |
| $10^{-6}$ M | 19.25 | 43.63 | 0.365 | 0.240 |
| $10^{-4}$M | 22.50 | 48.91 | 0.434 | 0.340 |
| $10^{-5}$ M $GA_3$ | 23.66 | 50.57 | 0.599 | 0.350 |
| $10^{-6}$ M | 18.72 | 46.36 | 0.312 | 0.250 |
| $10^{-4}$ M | 24.44 | 49.74 | 0.443 | 0.330 |
| $10^{-5}$ M IAA | 26.38 | 56.85 | 0.613 | 0.330 |
| $10^{-6}$ M | 22.32 | 47.91 | 0.402 | 0.240 |
| $10^{-4}$M | 24.94 | 57.70 | 0.653 | 0.300 |
| $10^{-5}$M SA+ $GA_3$ | 25.88 | 58.32 | 0.785 | 0.380 |
| 10-$^{6}$M | 22.67 | 47.22 | 0.336 | 0.220 |
| $10^{-4}$M | 21.51 | 55.24 | 0.634 | 0.350 |
| $10^{-5}$M SA+IAA | 23.67 | 56.25 | 0.702 | 0.390 |
| $10^{-6}$M | 21.11 | 48.39 | 0.415 | 0.210 |
| Kocide 101 | 23.44 | 50.28 | 0.626 | 0.240 |
| Control | 23.44 | 46.43 | 0.413 | 0.210 |
| LSD at 5% | 3.06 | 3.27 | 0.129 | 0.030 |

**Table (6): Effect of foliar spray of SA, $GA_3$ and IAA singly or in combinations on chocolate spot disease severity( DI) of faba bean cv. Giza 2 under field conditions during two seasons.**

| Treatment | Chocolate spot disease severity (DS) | | | |
|---|---|---|---|---|
| | 2011/2012 | | 2012/2013 | |
| | DS | Reduction% | DS | Reduction% |
| $10^{-4}$ M | 18.50 | 59.78 | 19.00 | 61.22 |
| $10^{-5}$ M SA | 16.75 | 63.59 | 18.00 | 63.27 |
| $10^{-6}$ M | 32.94 | 28.39 | 35.25 | 28.06 |
| $10^{-4}$M | 19.00 | 58.70 | 22.50 | 54.08 |
| $10^{-5}$ M $GA_3$ | 20.00 | 56.52 | 20.00 | 59.18 |
| $10^{-6}$ M | 32.94 | 28.39 | 33.67 | 31.29 |
| $10^{-4}$ M | 21.80 | 52.61 | 20.50 | 58.16 |
| $10^{-5}$ M IAA | 23.80 | 48.26 | 25.22 | 48.53 |
| $10^{-6}$ M | 34.00 | 26.09 | 37.99 | 22.47 |
| $10^{-4}$M | 15.00 | 67.39 | 24.00 | 51.02 |
| $10^{-5}$M SA+ $GA_3$ | 13.00 | 71.74 | 20.00 | 59.18 |
| 10-$^{6}$M | 26.50 | 42.39 | 28.00 | 42.86 |
| $10^{-4}$M | 19.00 | 58.70 | 20.00 | 59.18 |
| $10^{-5}$M SA+IAA | 16.50 | 64.13 | 18.00 | 63.27 |
| $10^{-6}$M | 25.00 | 45.65 | 29.00 | 40.82 |
| Kocide 101 | 11.00 | 76.09 | 14.00 | 71.43 |
| Control | 46.00 | ------ | 49.00 | ------ |
| LSD at 5% | 3.71 | | 4.26 | |

Data in Tables (5 and 6) show that the highest peroxidase activity and total phenol contents in addition to the lowest chocolate spot disease severity were obtained at the concentration of $10^{-5}$ M of either (SA+GA, SA+IAA and SA) treatments. Sarma *et al.* (2007) reported that chickpea foliar spray with zinc sulphate, oxalic acid, sodium malonate and sodium selenite reduced mortality of chickpea from *Sclerotina sclerotiorum*. HPLC analysis of treated chickpea leaves revealed the activation synthesis of several phenolic compounds after application and a positive correlation was observed between induction of phenolic compounds and survival of the plants. Foliar spray with different concentrations especially ($10^{-5}$M) conc. resulted in a significant increase in peroxidase and total phenols beside disease severity reduction compared with the untreated control Tables (5 and 6). Figures (1 and 2) illustrate negative correlation relationship between disease severity and peroxidase activity and accumulation of total phenols. Tarrad *et al.* (1993) and Cherif, *et al.* (2007) reported that the increase in peroxidase activity enhanced lignification in response to chocolate spot disease, which may restrict fungal penetration and play an important role in induced resistance of plant to the pathogen. Another supportive suggestions was made by Nawar and Kuti (2003), who stated that an increase in peroxidase activity is considered to be a preliminary indicator for resistance of broad beans to chocolate spot disease. Segarra *et al.* (2006) conducted a study on induction of resistance under the activity of chemical inducers against root rot diseases and found induced systemic resistance (ISR) rapidly developed in plants marking the resistance. They mentioned that chemicals play a role behind this resistance induction as accumulation of phytoalexins, lignifications of phenols and activation of chitinase, polyphenoloxidase and peroxidase.

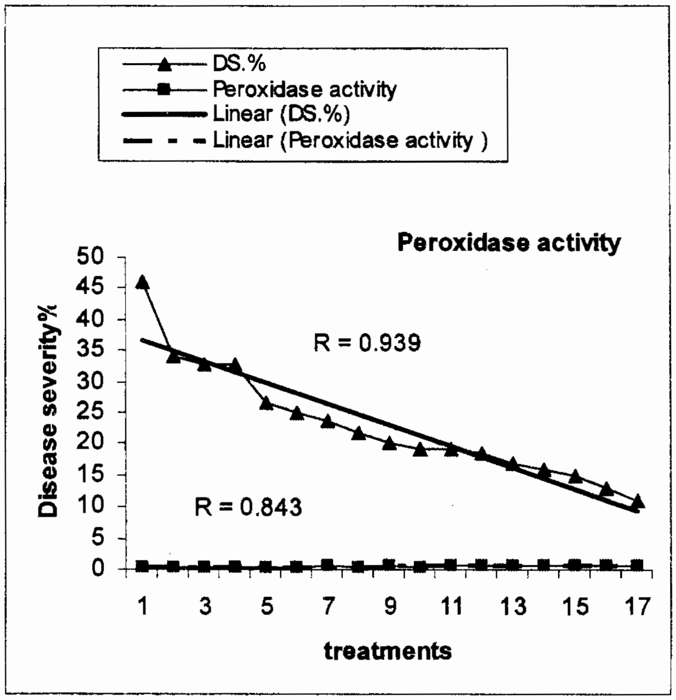


**Fig (1): Effect of foliar spray of SA, $GA_3$and IAA singly or in combinations on peroxidase activity and chocolate spot disease severity of faba bean cv. Giza 2 under field conditions and natural inoculation during first season.**

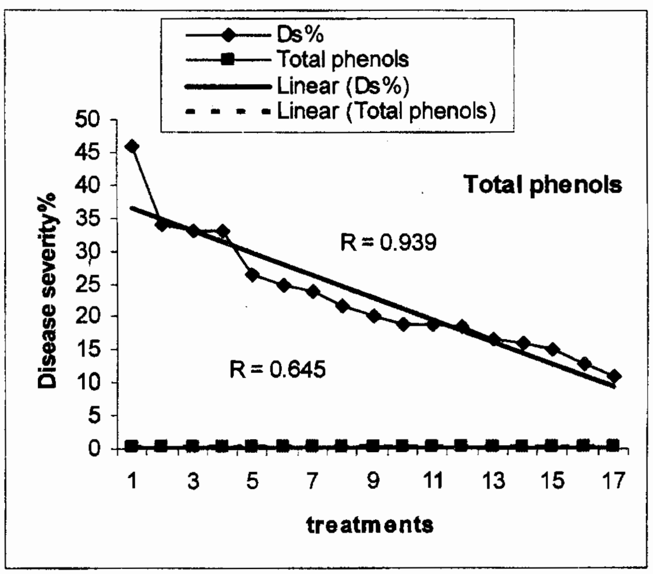


**Fig (1): Effect of foliar spray of SA, $GA_3$ and IAA singly or in combinations on total phenols content and chocolate spot disease severity of faba bean cv. Giza 2 under field and natural inoculation conditions during first season.**

## REFERENCES

Abdalla, M.M.A. and D.S. Darwish (2002). Faba bean in Egypt to tolerance orobanche: a review in Egypt J. Plant Breed. 6: 143-160.

Abdel-Fattah, M.A. (1997). Effect of phosphours, boron, $GA_3$ and their interaction on growth, flowering, pod setting, abscission and both green pod and seed yield of broad bean (*Vicia faba* L.) plants. Alex. J. Agric. Res., 42:311-332.

Abdel-Latef, A. A. (2003). Response of some sorghum cultivars to salt stress and hormonal treatment. M.Sc. Thesis. Fac. Agric. South. Valley Univ. Qena, Egypt.

Abdel-Latef, A.A., M.A. Shaddad, A.M. Ismail and M.F. Abou-Alhamd (2009). Benzyladenine can alleviate saline injury of two Roselle (*Hibiscus sabdariffa*) cultivars via equilibration of cytosolutes including anthocyanine. Int. J. Agric. Biol, 11: 151-157.

Amin, A.A., El-Sh. M. Rashad and Fatma A.E.G. (2006). Physiological responses of maize plants (*Zea mays* L.) to foliar application of morphactin CF125 and indole-3-butric acid. Journal of Biological Sciences 6: 547-554.

AOAC (1975). Official Methods of Analysis of the Association of Official Angricultural Chemists, Pub. A.O.A.C. Washington, D.C., U.S.A.

AOAC (1985). Official Methods of Analysis, 12th ed. Association of Official Analytical Chemists, Washington, D.C.,PP. 376-384.

Asharf, M.Y., N. Azhar and M. Hussain (2006). Indol acetic acid (IAA) induced changes in growth, relative water contents and gas exchanges attributes of barley (*Hordeum vulgare* L.) grown under water stress conditions. Plant Growth Regul., 50: 85-90.

Bardisi, A. (2004). Foliar application of some magnesium in comparison with kinetin on pea production under sandy soil conditions. Zagazig J. Agric. Res. 31: 1321-1334.

Bazzi, C., C. Messina, L. Tortoreto, F. Bini, GS Cecca and E. Stefani (2003a). Investigations on the possible use of biotic and abiotic elictiors in defence-related responses in plants. Eur. J. Hort. Sci., 68: 115-122.

Bazzi, C., C. Messina, L. Tortoeto, E. Stefani, F. Bini, A. Bru-nelli, A. Andreoti, E. Sabatini, F. Spinelli, G. Costa, S. Hauptmann, G. Stammler, S. Doerr, J. Marr and W. Ra- demacher (2003b). Control of pathogen incidence in pome fruits and other horticultural crop plants with prohexadione-Ca. Eur. J.Hort. Sci., 68: 108-114.

Bekheta, M.A. (2004). Combined effect of gibberellic acid and paclobutrazole on wheat plants grown in newly reclaimed lands. J. Agric., Sci., Mansoura Univ., 29: 4499-4512.

Brnce, A.P. (1990). The use of plant growth regulators to enhance yield and production efficiency of soybean (*Glycine max* L.). Dissertation Abst. Intrenational. B. Sci. Eng., 51: 2678B.

Cherif, M., A. Arfaoui and A. Rhaiem (2007). Phenolic compounds and their role in bio-control and resistance of chickpea to fungal pathogenic attacks. Tunisian Journal control of Plant Protection, 2: 7-21.

Chhun, T.S., S. Takcta, S. Tsurumi and I. Masahiko (2004). Different behaviour of indole-acetic acid and indole-3-butyric acid in stimulating lateral root development in rice ( *Oryza sativa* L.). Plant Growth Regul., 43: 135-143.

Chowdhury, A.K. (2003). Control of Sclerotium blight of groundnut by plant growth substances. Crop Research (Hisar), 25: 355-359.

Costa, C., C. Andreolti, F. Bueehi, E. Sabatini, C. Bazzi, S. Malaguti and W. Rademacher (2001). Prohexa- dion-Ca (Apogee ®): Growth regulation and reduced fire blight incidence in pear. Hort. Sci.,36: 931-933.

Dubois, M., K.A. Gilles, J.R. Hamilton and F. Smith (1956). Colorimetric method for determination of sugar and related substrance. Annal..Chem., 28: 350-356.

El-Bramawy, M.A.S. and O.A. Abdul Wahid (2007). Faba bean source of resistance to chocolate and spot diseases, earliness and seed yield. Pages 709-714.

Proceedings of the 7th African Crop Science Conference, December 5-9, 2007, Antipi, Uganda.
El-Desouky, S.M. (2006). Role of growth regulators in minimizing powdery and downy mildew infection on cucumber plants and their relation with endogenous phytohormones. Annals of Agric. Sci., Moshtohor, 44: 547-564.
El-Etr, W.M. (2000). Response of soybean to foliar spray with kinetin and zinc. J. Agric. Sci., Mansoura Univ., 25: 5557-5570.
El-Fiki, A.I.I., F.G. Mohamed and M.M.A. EL-Mansoub (2007). Studies on sugar beet rust disease in Egypt: Disease control and some vital activities of infected sugar beet plant grown under greenhouse conditions, Eleventh Congress of Phytopathology, Giza, Egypt, 25-39, (2007).
El-Korashy, M. (1998). Response of peanut cultivars to growth regulators and some soil borne fungi. Alex. Sci. Exch., 19: 51-60.
El-Nagar, Doa' A. R. (1998). Studies on induced resistance against stem rust of wheat. M. Sc. Thesis, Fac. Agric., Zagazig Univ., 105pp.
Gaber, A.M., O.A. EL-Shahaby and A.A. Ramadan (2000). Effect of some hormonal treatments on chemical composition and favism causative agents in the yielded seeds of *Vicia faba*. Egypt. J. Sci., 24-17-45.
Gozzo, F. (2004). Systemic acquired resistance in crop protection. Outlooks on Pest Management, 20-23.pp.
Gomez, K.A. and A.A. Gomez (1984). Statistical Procedures for Agricultural Research 2 nd, John Wiley and Sons, Inc., New York.
Hassan, M. E.M., S.S. Abd El-Rahman, I.H. El-Abbasi and M.S. Mjkhail (2006). Iducing resistance against Faba bean chocolate spot disease. Egypt. J. Phytopathol., 34, 1: 69-79.
Halbwirth, H., S. Martens, U. Wienand, G. Forkmann and K. Stich (2003). Biochemical formation of antho-cyanins in silk tissue of *Zea mays*. Plant Sci., 164: 489-495.
Hopkins, D.I. (1985). Effect of plant growth regulators on development of pierce 's disease symptoms in grapevine. Plant Disease, 69: 944-946.
Ibrahim, M.E., M.A. Bekheta, A. El-Moursi and N.A. Gaafar (2007). Improvement of growth and seed yield quality of *Vicia faba* L. plant as affected by application of some bioregulators. Australian J. of Basic and Applied Sci., 1, 4: 657-666.
ICARDA (1986). Screening techniques for disease resistance in faba bean: International Center for Agricultural Research in the Dry Area, Aleppo, Syria, p. 59.
Khalil, S. and H.M. Mandurah (1989). Growth regulation of grain filling in relation to peduncle anatomy in rice cultivars. Indian J. Exp. Biol., 25: 63-65.
Lee, H.S. (1990). Effect of pre-sowing seed treatments with $GA_3$ and IAA on flowering and yield components in groundnuts. Korean J. Crop Sci., 35: 1-9.
Marschner, H. (1986). Mineral Nutrition of Higher Plants. Academic Press, London.
Maxson, K.L. and A.L. Jones (2002). Management of fire blight with gibberelin inhibitors and SAR inducers. Acta Hort., 590: 217-223.
Mostafa, H.A.M., Hala, M.S. E.; Hemmat, K.I.K. and Mervat, S.S. (2005). Improving the characteristics of roselle seed as a new source of protein and lipid by gibberellin and benzyladenine application. J. of Applied Sci., Res.,1: 161-167.
Moran, R. and D. Porath (1980). Cholorophyll determination in intact tissues using N,N-dimethyl form amide. Plant Physiol., 65: 478-479.
Mukhtar, F.B. (2008). Effect of some plant growth regulators on the growth and nutritional value of *Hibiscus sabdariffa* L. (Red sorrel). Int. J. P. App. Sci., 2(3): 70-75.
Nair, S.A., V. Singhand and T.V. Sharma (2002). Effect of plant growth regulators on yield and quality of gerbera under Bay Island conditions. Indian J. Hort., 59: 100-105.
Nawar, H.F. and J.D. Kuti (2003). Wyerone acid phytoalexin synthesis and peroxidase activity as markers for resistance of broad bean to chocolate

spot disease. J Phytopathol., 151: 564-570.

Nowak, G., A. Klasa, J. Wirzbowska and M. Gotkiewicz (1997). Yield and macronutrient contents of field bean plants growning under conditions of growth relardant and phytohormone application. Part 1. crop yield. Biuletyn Instytutu. Hodowli, Aklimatyzacji-Roslin, 201: 289-296.

Oostendorp, M., W. Kunz, B. Dietrich and T. Staub (2001). Induced disaess resistance in plants by chemicals. Eur. J. Plant Pathol., 107, 19-28.

Paricha, P.C., B.K. Ghosh and N.C. Saboo (1977). Further studies on the significance of cycocel on enhancing drought rsistance in rice. Science and Culture. 43: 230-231.

Peleg, Z. and E. Blumwald (2011). Hormone Balance and Abiotic Stress Tolerance in Crop Plants. Current Opinion in Plant Biology In Press, Corrected Proof.

Pozo, M.J., L.C. Van loon and C.M. Pieterse (2005). Jasmontes-signals in plant-microbe interactions. J. Plant Growth Regul, 23:211-222.

Rabie, K.A. (1996). Studies on the interaction between gibberellin and benzyladenine in regulating growth, yield and phytohormone content in wheat plants. Annals Agric. Sci., Ain Shams Univ., Cairo,41: 99-110.

Rademacher, W. and T. Bucci (2002). New plant growth regulators: High risk investment? Hort. Technol., 12: 64-67.

Ragab, E.A., M. Hosny, H.A. Kadry and H.A. Ammar (2009). Flavanone glycosides from *gleditisia caspi.* J. Nat. Prod.,

Rajkumar, M., K.J. Lee and H. Freitas (2008). Effects of chitin and salicylic acid on biological control activity of *Pseudomonas spp.* against damping off of pepper. South African J. of Bot., 74: 268-273.

Ramadan, A.A. (1998). Studies on the effect of some physiological factors on growth, yield, metabolism and favism causative agent on *vicia faba* plants. Ph.D.Thesis, Mansoura Univ., Egypt.

Rodica, C. (2012). The influence of *Taphrina deformans* (Berleley) tulasne (peach leaf curl) attack on the activity of some oxidoreductases in cultivar cardinal. Journal of Faculty of Food Engineering. 4: 30-33.

Roemmelt, S., N. Zimmermann, W. Rademacher and D. Treutter (2003). Unusual flavonoid roultes induced by the dioxgenase inhibitor prohexadione-Ca in apple (*Malus domestica*). Phytochemistry. 64: 709-716.

Ryals, J.S.U. and E. Ward (1994). Systemic acquired resistance. Plant Physiol., 104: 1109-1112.

Sanaa, A.M., M.A. Mostafa and S.A.M. Shehata (2006). Physiological studies on the effect of kinetin and salicylic acid on growth and yield wheat plant. Annals Agric. Sci., Ain Shams Univ., Cairo, 51: 41-55.

Sarkar, P.K., M.S. Haque and M.A. Karim (2006). Effect of $GA_3$ and IAA and frequency of application on morphology, yield contributing characters, and yield of soybean. J. Agron., 1: 119-122.

Sarma, B.R., B. Ameer, D.P. Sing and U.P. Singh (2007). Use of non- conventional chemicals as an alternative approach to protect chickpea (*Cicer arietinum*) from Sclerotinia stem rot. Crop Prot., 26: 1042-1048.

Saswat, B., R.P. Purkayasha and S. Biswas (1988). Induction of resistance in rice plants against sheath rot disease. Indian Phytopathol., 41: 51-56. (c.f. CAB Abstr).

Segrra, G., O. Jauregui, E. Casanova and I. Trillas (2006). Simultaneous quantitative LC-ESI- MS/MS analysis of salicylic acid and jasmonic acid in curde extracts of *Cucumis sativus* under biotic stress. Phytochemistry, 67:4:385-401.

Shafique, S., T. Anjum, S. Shafique, A. Ahmad, W. Akram and Z. Bashir (2011). Induction of systemic difenses in plant under the activity of dynamic. Mycopath 9 (2): 95-104.

Shalaby, M.A.F. and M.A. Ahmed (1994). Yield response of faba bean to some foliar fertilizers in relation to IAA treatments. Egypt J. Agron., 19: 113-125.

Shehata, S.A.M., M.A. Saeed and M.S. Abou-El-Nour (2000). Physiological response of coton plant to the foliar spray with salicylic acid. Annals Agric. Sci., Ain Shams Univ. Cario. 45:1-18.

Sivakumar, R., G. Pathmanaban, M.K. Kalarani, V. Mallika, P.S. Srinivasan and M. Vanangamudi (2002). Effect of foliar application of growth regulators on biochemical attribute and grain yield in pearl millet. Indian J. Plant Phsiol., 7: 79-82.

Tarrad, A.M., Y.Y. El-Hyatemy and S.A. Omar (1993). Wyerone derivatives and activities of peroxidase and polyphenoloxidase in faba bean leaves as induced by chocolate spot disease. Plant Sci. 89: 161-165.

Thimmaiah, S.K. (1999). Standard Methods of Biochemical Analysis. Kalyani Publishers. New Delhi.

Tivoli, B., P. Berthelem, J. Le Guen and C. Onfroy (1988). A study of the performance of certain faba bean genotypes in relation to *Botrytis fabae* and *Ascochyta fabae* in France. FABIS Newsltt. 21: 36-39.

Torres, AM., B. Roman, CM Avila, Z. Sativic, D. Rubiales, JC. Sillero, JL Cubero and MT Moreno (2004). Faba bean breeding for resistance against biotic stresses: towards application of marker technology. Euphtica. 147: 67-80.

Vlot, A.C., D.M.A. Dempsey and D.F. Klessig (2009). Salicylic acid, a multifaceted hormone to combat disease. Annul Review of Phytopathology 47: 177-206.

Wang, Y., Y. Zhang and J. Zhang (2010). Effects of salicylic acid on the behavior of Yali pear infected by *Alternaria kikuchiana*. Tanaka. Front. Agric. China, 4, 1: 79-83.

Ward, E.R., S.J. Uknes, S.C. Williams, S.S. Dincher, D.L. Wiederhold and J.A. Ryals (1991). Coordinate gene activity in response to agents that induce systemic aquired resistance. Plant Cell. 3: 1085-1094.

Wasternack, C., I. Stenzel, B. Hause, G. Hause, C. Kutter, H. Maucher, J. Neumerkel, I. Feussner and O. Miersch (2006). The wound response in tomato-role of jasmonic acid. J. Plant Pathol., 163 (3): 297-306.

Wheeler, B.J. (1969). An Introduction to Plant Diseases. John Wiley, London.

Williams, MS (2010). Introduction to phytohormones. The Plant Cell. 22: 1-9.

Yehia, A. G. M., S.M. Abu El Souod, A. Saeid, I. Abd-Elwahab, A. Magid and K. E. Mohsen (2011). Recent approaches controlling brown spot disease of faba bean in Egypt. Egyt. Acad. J. Biology. Sci., 3 (1): 41-53.

Yi, L.X. (1986). Faba bean disease in China. Faba Bean Information Service Newsltter. 15: 49-51.

# تأثير المعاملة الورقية لحمض الجبريليك وإندول حمض الخليك وحمض الساليسيلك على نمو ومحصول الفول البلدى وكذلك على شدة إصابتة بالتبقع الشكولاتى

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## الملخص العربى

تحت ظروف الحقل بمحطة البحوث الزراعية – إيتاى البارود– محافظة البحيرة لموسمين متتالين ٢٠١٢/٢٠١١ و٢٠١٣/٢٠١٢تم دراسة تأثير كل من حمض الساليسيلك وحمض الجبريليك وإندول حمض الخليك ومخاليطهم عند تركيزات ١٠<sup>-٤</sup> ,١٠<sup>-٥</sup> ,١٠<sup>-٦</sup> مولار على مقاومة مرض التبقع الشيكولاتى فى الفول البلدى صنف جيزة ٢ وكذلك على بعض الصفات المحصولية والمحصول البذرى وبعض التغيرات البيوكيمائية (محتوى الأوراق من الكلوروفيل ا,ب والكلى وكذلك نشاط إنزيم البيروكسيديز والمحتوى الكلى للفينول). وجد أن رش حمض الجبريليك و حمض الساليسيلك + إندول حمض الخليك عند تركيز ١٠<sup>-٥</sup> مولار أدى إلى زيادة فى إرتفاع النبات والوزن الرطب والجاف للمجموع الخضرى مقارنة بالنباتات غير المعاملة. كما وجد زيادة فى بعض الصفات المحصولية وهى طول النبات ,عدد الفروع/نبات ,عددالقرون/نبات ,عدد البذور/نبات , وزن ١٠٠ بذرة والمحصول البذرى نتيجة للمعاملات بحمض الجبريليك وإندول حمض الخليك وحمض الساليسيلك + إندول حمض الخليك عند تركيز ١٠<sup>-٤</sup> و ١٠<sup>-٥</sup> مولار. بصفة عامة المحتوى الكلوروفيل أ وب و كذلك الكلوروفيل الكلى أ+ب ونشاط إنزيم البيروكسيديز يزداد عند كل المعاملات ذات التركيز ١٠<sup>-٤</sup> و ١٠<sup>-٥</sup> مولار. وجد أن أعلى معدل زيادة فى محتوى البذور من البروتين والكربوهيدرات عند المعاملة بإندول حمض الخليك ,حمض الساليسيلك + حمض الجبريليك عند التركيز ١٠<sup>-٥</sup> مولار بنسبة ٢٦,٣٨ , ٢٥,٨٨ % للبروتين و ٥٨,٣٢ ,٥٦,٨٥% للكربوهيدرات على التوالى. وجد أن كل المعاملات عند التركيز ١٠<sup>-٤</sup> و ١٠<sup>-٥</sup> مولار تقلل من شدة الإصابة بالتبقع الشيكولاتى مقارنة بالكنترول.وظهرت أعلى مقاومة لشدة الإصابة عند المعاملة بالمبيد كوسيد ١٠١يليها حمض الساليسيلك + حمض الجبريليك , حمض الساليسيلك + إندول حمض الخليك عند التركيز ١٠<sup>-٥</sup> مولار بنسة ١١,٠٠ ,١٣,٠٠ ,١٦,٥٠ % على الترتيب فى الموسم الأول أما فى الموسم التالى تساوى تأثير المعاملة وحمض الساليسيلك +إندول حمض الخليك مع المعاملة بحمض الساليسيلك عند التركيز ١٠<sup>-٥</sup> مولار بنسبة ١٨,٠٠%. وبناء على ماسبق يمكن الإستنتاج أن المركبات الكيمائية المستخدمة يمكنها مقامة التاثير المدمر لفطر البوتريتس فابى على مستوى النمو والإنتاجية للفول البلدى.