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# EFFECT OF SULPHUR FERTILIZATION ON *IBERIS AMARA* PLANT AND ITS INSECTICIDAL ACTIVITY

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## ABSTRACT

The effect of different types of sulphur on growth and chemical constituents of *Iberis amara* was studied for two successive seasons (2003 & 2004). The insecticidal activity of different extracts of *I. amara* on cabbage aphid was investigated. Ammonium sulphate increased plant height and flowers fresh and dry weight as compared to both potassium and sulphur. Ammonium sulphate at 120 kg S $ha^{-1}$ led to increase suckers number, herb fresh weight, seed yield per increase plant, the highest contents of carbohydrate (13.95%, 14.0%) and fixed oils (13.62%, and 12.85%) for the first and second seasons, respectively and also highest contents of glucosinolates and phenolic compounds, while cucurbitacins showed a maximum with treatment of 90 kg S $ha^{-1}$ ammonium sulphate. The highest concentration of ethanol extract induced the highest mortality for cabbage aphid (66.67% mortality after 96 hr), followed by water extract after autolysis and chloroform extracts, both of which induced 53.33% mortality at the highest concentrations tested, hexane extract showed the least effect on target insect.

## 1. INTRODUCTION

Numerous challenges should be resolved for better production of different agricultural crops, e.g. mineral/chemical vs. bio- fertilizer/pesticides, in particular to provide food and cure for the growing populations. Sulphur (S) fertilization is of growing worldwide importance while food production increases, despite the fact that overall S inputs reduce. Sulphur is one of the nutrient elements essential for plant growth. Its functions within the plant are related closely to those of nitrogen and the two nutrients are synergistic. Sulphur is required for plant growth in quantities equal to and/or > those of phosphorus (P). Sulphur has a variety of crucial functions within biochemistry of the plant. S fertilization has been shown to increase protein and sugar contents, it is also essential in the formation of enzymes, vitamins, such as biotin and thiamine, and a variety of other important compounds in the plant, including chlorophyll. The oil content of seeds is diminished and the maturity of fruits is delayed in the absence of adequate S **(Ceccotti, 1996)**. Sulphur fertilizer applications have worldwide shown little historic growth, because the value of S as a component of multi-nutrient fertilizers was not recognized **(Ceccotti, 1994)**. The amount of S consumed in all S-containing fertilizers fluctuated worldwide around 10 million mg per year during the last 20 years, while the consumption of N almost doubled during this period of time from about 39 million mg in 1973 to almost 75 million mg in 1991.

The genus *Iberis* (*Brassicaceae*) is an annual, white to violet blooming plant, reaching up to 40 cm in height, with a strong specific smell, and a sharp cress-like taste. The genus *Iberis* grows in

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Europe, mainly in the Mediterranean region (**Reichling *et al* 2003**).

With regard to phytotherapy uses, *Iberis amara* (Bitter candytuft) is used in the treatment of digestive, hepatic, and vesicle diseases, and has anti-inflammatory activity. It is traditionally taken to treat gout, rheumatism, and arthritis. All parts of the plant are anti-rheumatic and anti-scorbutic. The seeds are considered very useful in the treatment of asthma, bronchitis, and dropsy (**Bezanger-Beauquesne *et al* 1990 and Fabre *et al* 2000**). This plant also has shown the antifeedant activity against larvae of *Pieris rapae* ( **Huang *et al* 1997**).

Many plant secondary compounds have been shown to affect insect growth, development, or fecundity, and are consequently believed to play a role in the deterrence of insect attack (**Sarker *et al* 1999**). Crop loss due to insect pests varies between 10% and 30% for major crops (**Ferry *et al* 2004**). Management of agricultural pests over the past half century has been largely dependent on the use of synthetic chemical pesticides for field and post-harvest protection of crops. Potential problems associated with continued long-term use of toxic insecticides include pest resistance and negative impact on natural enemies. In addition, increasing documentation of negative environmental and health impact of synthetic toxic insecticides and increasingly stringent environmental regulation of pesticides have resulted in renewed interest in the development and use of botanical pest management products by agrochemical companies (**Isman, 2000**).

Maximizing and resolving economic and environmental demands in agricultural practices, the critical role of S for agro ecosystems and especially the importance of S fertilization in optimizing crop exploitation of other nutrients, in particular N, must be reconsidered. Indeed, severe S deficiency in agricultural crops poses a major problem in northern Europe with strong ecological impacts. An insufficient S supply not only will reduce yields, but also will decrease quality of food. Additionally, S deficiency reduces the efficiency of N fertilizer, that lets to damaging N losses to the environment (**Ceccotti, 1996**).

This study, amid to investigate the effects of different sources of sulphur on growth and chemical constituents of *Iberis amara* plants grown in Egypt, and also the insecticidal activity of different extracts of *I. amara* on cabbage aphid.

## 2. MATERIALS AND METHODS

### 2.1. Plant materials and cultivation of *I. amara*

This study was carried out during two successive winter seasons (2003 and 2004) at the National Research Centre (NRC) Experimental Farm Station, Al-Giza Governorate. This study investigated the effect of fertilizing with different forms of sulphur on the growth, yield, and chemical composition of *Iberis amara* plants. Seeds of *Iberis amara* L. were obtained from Horticulture Department Station, Faculty of Agriculture, Moshtoher, Benha University. The seeds were sown on the 28$^{th}$ of October during the both seasons. Seeds were sown directly at 40 cm apart in rows 50 cm wide. Irrigation was applied as required. The chemical and biological studies were investigated during the season of 2005.

Samples from the soil of the experimental field were taken for determination of the physical and chemical analysis according to **Chapman and Pratt, (1978)**. The obtained results are shown in **Table (1)**.

Three forms of sulphur were applied as follows:

1. Potassium sulphate (18% S, 48% K2O) at rates of 60, 90, and 120 kg S ha$^{-1}$
2. Ammonium sulphate (24% S, 20.8% N) at rates of 60, 90, and 120 kg S ha$^{-1}$
3. Sulphur (99.88% S) at rates of 60, 90, and 120 kg S ha$^{-1}$

A basal dosage of 240 kg ha$^{-1}$ of calcium super phosphate (15.5% $P_2O_5$) and compost (47 m$^3$ of compost ha$^{-1}$) were applied during ploughing to the control and all plots of the three treatments mentioned above. Chemical composition of the compost used in this experiment is shown in **Table (2)**. Each treatment was conducted with three replicates, 4 m$^2$ plot$^{-1}$, distributed in a complete randomized design. The treatments were added as side dressings in two doses, the first one was added on 8 February and the second one was on 10 March in the two seasons. Seed oil yield was determined at the maturity stage in May for each of the two seasons, and the following plant parameters were measured at the 75% flowering stage in April: plant height (cm), fresh and dry weight (g)/plant, flowers (fresh and dry weights), number of suckers, number of branches and seed weight/plant.

**2.2. Sample preparation and chemical analyses**

The carbohydrates and/or glycosides content, flavonoids, sterols and/or triterpenes, coumarins, alkaloids, saponins, tannins, thio acids (glucosinolates) and cucurbitacins were determined in the air dried plant leaves as mentioned by **Balbaa, (1974) & Attard and Scicluna-Spiteri, (2001).**

The cucurbitacin compounds were extracted from dried plant leaves (2 g) with absolute ethanol (15 ml) for 2 hr and then filtered. The filtrate was adjusted to 50 ml with absolute ethanol in a volumetric flask and the total cucurbitacins were determined according to **Attard and Scicluna-Spiteri, (2001).**

Glucosinolates are known to decompose in an alkaline medium, so sinigrin is degraded to 1-thioglucose, vinyl glycine and sulphate as follows:

$$Sinigrin \xrightarrow[pH>7]{OH} C_6H_{11}O_5S^- + C_3H_5O_2N + SO_4^{-2}$$

Thiol compounds are known to be readily oxidized by ferricyanide. The reduction of ferricyanide ion was measured by spectrophotometer at 420 nm. Two grams of dried powdered samples were added to a boiling acetate buffer (pH 4.2, 0.2 M, 7.5 ml). The mixture was kept in a boiling water bath for 15 min. After cooling, the extract was treated according to the method of **Jezek *et al* (1999).**

The colourimetric method of Folin-Denis as described by **Swain and Hillis, (1959)** was employed for the determination of phenolic compounds in the herbs. Total soluble sugars were determined in the ethanolic extract of plant material using the phenol-sulphuric method **(Dubois *et al* 1956).** Fixed oil of seed was determined according to **A.O.A.C., (1995).**

**2.3. Insect culture**

**2.3.1. Cabbage aphid (*Brevicoryne brassicae*)**

Stock culture of cabbage aphid was maintained on seedling broccoli under laboratory conditions of 18±5°C, 65±5 % R.H., and 8 hr daily photo phase. The seedlings of broccoli used for the present experiments were grown to the 8-10 leaf stage in a mixture of clay (50%), sand (30%), and peat moss (20%) in 15-cm pots. Newly born apterous adults were transferred to broccoli seedlings previously planted in pots.

**2.3.2. Toxicological studies**

The thin-film technique was carried out during 2005 as follows: each plastic petri dish (5 cm diameter) had a 2 cm hole covered with muslin, which was fixed in place using melted rubber to prevent the insect from escaping and to allow breathing. A section of broccoli plant including the stem and one leaf (1 month old) was placed into the modified petri dish and the stem was surrounded by a soaked piece of cotton to keep the leaves fresh and supplied with water daily during the experimental period. Five ml of each concentration (1, 2, and 4% w/v) were evenly applied on a modified petri dish as well as the fresh leaves. The solvent was allowed to evaporate for a few minutes, leaving a thin film of the plant extract or the isolated compounds. Fifteen newly emerged adults were placed singly on the treated or control leaves in modified petri dishes as described previously. The mortality percentage was recorded after 24, 48, 72, and 96 hr and corrected using Abbot's formula **(Abbot, 1925).**

**2.4. Statistical analysis**

All experimental results were statistically analysed using CoStat Version 3.03, an interactive statistics program for computers. F-test and the least significant difference (LSD) were used for the comparison between treatment means at 5% probability level **(Waller and Duncan, 1969).**

## 3. RESULTS AND DISCUSSION

**3.1. Preliminary phytochemical screening of the dried powder and extracts of *Iberis* plants**

Results of the preliminary phytochemical screening of *Iberis amara* plants, as shown in **Tables (3 and 4),** showed some variations. For instance, carbohydrates and/or glycosides were present in both ethanol and water extracts of dried leaves due to the natural solubility of these compounds and were not fractionated into other non-polar solvents. Cucurbitacins were present in ethanol, benzene, and chloroform extracts, while glucosinolates were present only in ethanol and water extracts. Coumarins, tannins, saponins, and alkaloids were not detected.

### 3.2. Effect of different sources of sulphur fertilization on growth and yield

**Table (5)** shows the effect of different types of sulphur fertilization on growth and yield of *Iberis amara* plants for two successive seasons. The obtained data in the first season revealed that the plant height, number of suckers, and number of branches are affected relative to the type of sulphur fertilization. Plant height increased with increasing S amount of the three S forms; potassium sulphate, ammonium sulphate, and sulphur. Comparing the plant height induced by different types of sulphur, potassium sulphate is more effective than both ammonium sulphate and sulphur on plant height where the plant height reached 74 cm during 1st season. The number of suckers was also affected by the different treatments; the highest number (48/plant) was obtained with treatment of 120 kg S $ha^{-1}$ in a form of ammonium sulphate during 1st season. The number of branches reached a maximum of 35/plant with treatment of 120 kg S $ha^{-1}$ in a form of sulphur. The highest fresh weight of herb and seed weight/plant reached 340 g and 35 g/plant, respectively when the plants were treated with 120 kg S $ha^{-1}$ in a form of ammonium sulphate. Flowers had the highest fresh weight (278 g/ plant) with the treatment of 120 kg S $ha^{-1}$ in a form of potassium sulphate. The same trends were seen in the second season, but with slight differences in values.

**Choi *et al* (2006)** studied the effect of plants on the biogeochemistry of sulphur species and the mobility of heavy metals in wetland sediments. Results showed that, in the presence of plants, sediments had elevated sulphate concentrations in the rhizosphere during the growing season, ranging from 0.2 to 6.20 mmol/L, whereas only a small difference in the sulphate profiles between vegetated and non-vegetated sediments was observed during senescence.

**Yang *et al* (2006)** studied the in situ suspended farming of *Gracilaria lemaneiformis* using raft cultivation under different conditions and its effects on nutrient removal in the laboratory. The results showed that cultivated *G. lemaneiformis* grew well in both Shenao Bay and Jiaozhou Bay. The biomass of *Gracilaria* increased from 50 to 775 g m−1 (fresh weight) during 28 days, with special growth rate 13.9% d−1 under horizontal cultivation in Jiaozhou Bay. Light, temperature, nutrient supply, as well as cultivation treatments such as initial density, and depth of suspension seaweed were important to the growth of *Gracilaria*. In the laboratory, the aquarium experiments (fish and seaweed culture systems) demonstrated that *Gracilaria* was able to remove inorganic nutrients effectively. The concentration of NH4 ± N decreased by 85.53% and 69.45%, and the concentration of PO4–P decreased by 65.97% and 26.74% in aquaria with *Gracilaria* after 23 days and 40 days, respectively. The results indicate that *Gracilaria* has the potential to remove excess nutrient from coastal areas, and the large-scale cultivation of *G. lemaneiformis* could be effective to control eutrophication in Chinese coastal waters.

### 3.3. Effect of different sources of sulphur fertilization on total carbohydrates and fixed oils

**Table (6)** presents the effect of different types of sulphur fertilization on total carbohydrates and fixed oils in *I. amara* plants during two successive years. The obtained data revealed that both total carbohydrates and fixed oils were affected by different types of sulphur fertilization. Both carbohydrates and fixed oils content gradually increased with increasing levels of potassium sulphate, ammonium sulphate, and sulphur. Treatment with ammonium sulphate at a rate of 120 kg S $ha^{-1}$ was the most effective where total carbohydrate and fixed oils contents reached 13.95%, 13.62%, and 14.00%, 12.85% in the first and the second season, respectively. This may be attributed to the fact that ammonium sulphate as a source of nitrogen may increase the capacity of this plant to build an active ingredients production or increase the capacity of *de novo* meristematic cell metabolism **(Omer, 1998).**

### 3.4. Effect of different sources of sulphur fertilization on total cucurbitacins, total glucosinolates, and total phenolic compounds

The quantity of cucurbitacins, glucosinolates and phenolic compounds in the plants treated with different types of sulphurs was presented in **Table (6)**. The data showed that cucurbitacins, glucosinolates and phenolic compounds were significantly affected by the different treatments. The highest content of glucosinolates and phenolic compounds were observed in the first season when the plants were treated with 120 kg S $ha^{-1}$ in a form of ammonium sulphate, while cucurbitacin content reached 0.87% when treated with 90 kg S $ha^{-1}$ in a form of ammonium sulphate. The same

Table 1. Physical and Chemical properties of the soil used for growing *Iberis amara*

| Fine sand | Silt | Clay | Organic matter | Total N | Total $P_2O_5$ | Total $K_2O$ | pH | EC | Soluble cations and anions mg $l^{-1}$ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | % | % | g | ppm | ppm | Ppm | | | $Na^+$ | $Mg^{2+}$ | $Ca^{2+}$ | $HCO_3^{1-}$ | $Cl^{1-}$ | $SO_4^{2-}$ |
| 55 | 29.75 | 14.94 | 0.23 | 480 | 37.8 | 35.7 | 8.23 | 2.8 | 9.5 | 8.2 | 14 | 4.4 | 13 | 2.5 |

Table 2. Chemical composition of the compost

| Moisture content | Total organic carbon (%) | Total organic matter | Total N | Total P | Total K | Bulk density kg m-3 | EC | pH | C/N ratio | NH4-N | NO3-N | Available P | Available K | Fe | Zn | Mn | Cu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | | | | | | | | | | mg kg-1 | mg kg-1 | mg kg-1 | mg kg-1 | ppm | | | |
| 18.2 | 24.6 | 42.41 | 1.35 | 1.6 | 2.3 | 510 | 9.35 | 7.4 | 18.2 | 880 | 450 | 410 | 620 | 960 | 280 | 320 | 140 |

Table 3. Preliminary phytochemical screening of the dried powder of *Iberis amara* plants

| Carbohydrates and/or Glycosides | Flavonoids | Saponins | Tannins | Thio acids | Sterols and/or triterpenes | Alkaloids | Coumarins | Cucurbitacins | Glucosinolates |
|---|---|---|---|---|---|---|---|---|---|
| ++ | ± | - | - | +++ | + | - | - | ++ | +++ |

The symbols +++, ++, +, ±, – indicate the compounds were present in high, moderate, low, trace, and absent levels, respectively

Table 4. Preliminary phytochemical screening of *Iberis amara* extracts

| Tested extracts | Carbohydrates and/or Glycosides | Flavonoids | Saponins | Tannins | Thio acids | Sterols and/or triterpenes | Alkaloids | Coumarins | Cucurbitacins | Glucosinolates |
|---|---|---|---|---|---|---|---|---|---|---|
| Ethanol | ++ | ± | - | - | +++ | + | - | - | ++ | +++ |
| n-Hexane | - | - | - | - | - | + | - | - | - | - |
| Benzene | - | - | - | - | - | - | - | - | + | - |
| Chloroform | - | - | - | - | - | - | - | - | + | - |
| Ethyl acetate | - | - | - | - | - | - | - | - | - | - |
| Water | ++ | - | - | - | +++ | - | - | - | - | +++ |

The symbols +++, ++, +, ±, – indicate the compounds were present in high, moderate, low, trace, and absent levels, respectively.

Table 5. Effect of different sources of sulphur fertilization on growth and yield of *Iberis amara* plants during two successive seasons

| Treatments | Dose (kg S/ha) | Plant height (cm) | | Number of suckers | | Number of branches | | Fresh weight of herb g/plant | | Dry weight of herb g/plant | | Flowers fresh weight g/plant | | Flowers dry weight g/plant | | Seed weight g/plant | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | I* | II* | I | II | I | II | I | II | I | II | I | II | I | II | I | II |
| **Control** | 0 | 48.30 | 52.60 | 20.00 | 23.00 | 17.00 | 18.00 | 180.00 | 195.00 | 21.05 | 22.81 | 143.60 | 151.00 | 15.12 | 15.89 | 18.00 | 21.00 |
| **Potassium sulphate** | 60 | 53.00 | 58.30 | 24.00 | 25.00 | 21.00 | 21.00 | 200.00 | 240.00 | 23.39 | 28.07 | 182.40 | 180.00 | 19.20 | 18.95 | 24.00 | 25.00 |
| | 90 | 65.70 | 66.30 | 34.00 | 32.00 | 29.00 | 25.00 | 212.00 | 288.00 | 24.80 | 33.68 | 224.00 | 218.00 | 23.58 | 22.95 | 26.00 | 28.00 |
| | 120 | 74.00 | 72.35 | 42.00 | 38.00 | 30.00 | 31.00 | 321.00 | 312.00 | 37.54 | 36.49 | 278.00 | 255.00 | 29.26 | 26.84 | 31.00 | 30.00 |
| | Mean | 64.23 | 65.65 | 33.33 | 31.67 | 26.67 | 25.67 | 244.33 | 280.00 | 28.58 | 32.75 | 228.13 | 217.67 | 24.01 | 22.91 | 27.00 | 27.67 |
| **Ammonium Sulphate** | 60 | 65.30 | 62.70 | 38.00 | 31.00 | 18.00 | 22.00 | 280.00 | 285.00 | 35.67 | 36.31 | 161.30 | 185.00 | 15.81 | 18.14 | 22.00 | 24.00 |
| | 90 | 64.30 | 67.30 | 42.00 | 38.00 | 21.00 | 26.00 | 340.00 | 330.00 | 43.31 | 42.04 | 195.60 | 245.00 | 19.18 | 24.02 | 24.00 | 30.00 |
| | 120 | 72.70 | 74.30 | 48.00 | 44.00 | 25.00 | 32.00 | 340.00 | 355.00 | 43.31 | 45.22 | 218.00 | 274.00 | 21.37 | 26.86 | 35.00 | 36.00 |
| | Mean | 67.43 | 68.10 | 42.67 | 37.67 | .21.33 | 26.67 | 320,00 | 323.33 | 40.76 | 41.19 | 191.63 | 234.67 | 18.79 | 23.01 | 27.00 | 30.00 |
| **Sulphur** | 60 | 58.30 | 62.70 | 26.00 | 28.00 | 18.00 | 21.00 | 280.00 | 275.00 | 35.00 | 34.38 | 185.50 | 194.00 | 20.16 | 21.09 | 21.00 | 23.00 |
| | 90 | 65.70 | 66.30 | 28.00 | 35.00 | 22.00 | 27.00 | 320.00 | 330.00 | 40.00 | 41.25 | 228.90 | 236.00 | 24.88 | 25.65 | 25.00 | 29.00 |
| | 120 | 69.70 | 71.60 | 39.00 | 41.00 | 35.00 | 30.00 | 335.00 | 350.00 | 41.88 | 43.75 | 247.00 | 265.00 | 26.85 | 28.80 | 29.00 | 33.00 |
| | Mean | 64.57 | 66.87 | 31.00 | 34.67 | 25.00 | 26.00 | 311.67 | 318.33 | 38.96 | 39.79 | 220.47 | 231.67 | 23.96 | 25.18 | 25.00 | 28.33 |
| **LSD (5%)** | | 2.86 | 2.54 | 2.34 | 2.06 | 1.31 | 1.11 | 27.16 | 29.12 | 2.22 | 2.14 | 18.30 | 16.33 | 1.54 | 1.64 | 2.13 | 1.95 |

* I= first season, II= second season

Table 6. Effect of different types of sulphur fertilization on chemical composition of *Iberis amara* plants during two successive seasons

| Treatments | Dose (kg S/ha) | Total cucurbitacins (% W/W, dry weight) | | Total glucosinolates (mMol/kg, dry weight) | | Total phenolic compounds (% W/W, dry weight) | | Total carbohydrates (% dry weight) | | Fixed oil (% dry weight) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | I* | II* | I | II | I | II | I | II | I | II |
| Control | 0 | 0.38 | 0.31 | 4.12 | 3.85 | 0.94 | 0.88 | 9.24 | 8.38 | 6.64 | 6.14 |
| Potassium sulphate | 60 | 0.39 | 0.32 | 7.14 | 6.86 | 0.96 | 0.98 | 11.25 | 10.45 | 7.12 | 6.18 |
| | 90 | 0.44 | 0.41 | 7.88 | 7.17 | 0.99 | 1.03 | 11.89 | 12.38 | 9.11 | 8.95 |
| | 120 | 0.45 | 0.50 | 8.02 | 7.87 | 1.15 | 1.18 | 12.16 | 13.21 | 11.32 | 10.88 |
| | Mean | 0.43 | 0.41 | 7.68 | 7.30 | 1.03 | 1.06 | 11.77 | 12.01 | 9.18 | 8.67 |
| Ammonium Sulphate | 60 | 0.60 | 0.52 | 8.19 | 8.14 | 1.01 | 1.07 | 11.34 | 11.35 | 12.35 | 11.78 |
| | 90 | 0.87 | 0.80 | 8.34 | 8.18 | 1.08 | 1.11 | 12.16 | 12.38 | 12.38 | 12.36 |
| | 120 | 0.85 | 0.77 | 9.37 | 9.11 | 2.11 | 1.98 | 13.95 | 14.00 | 13.62 | 12.85 |
| | Mean | 0.77 | 0.70 | 8.63 | 8.48 | 1.40 | 1.39 | 12.48 | 12.58 | 12.78 | 12.33 |
| Sulphur | 60 | 0.55 | 0.54 | 7.02 | 6.90 | 0.98 | 1.04 | 11.45 | 11.68 | 8.15 | 9.14 |
| | 90 | 0.61 | 0.67 | 7.88 | 7.40 | 1.12 | 1.18 | 12.12 | 11.85 | 9.38 | 9.58 |
| | 120 | 0.67 | 0.69 | 8.84 | 8.15 | 1.20 | 1.24 | 13.25 | 12.43 | 11.27 | 10.36 |
| | Mean | 0.61 | 0.63 | 7.91 | 7.48 | 1.10 | 1.15 | 12.27 | 11.99 | 9.60 | 9.69 |
| LSD (5%) | | 0.02 | 0.03 | 1.17 | 1.08 | 0.10 | 0.09 | 0.64 | 0.58 | 1.10 | 0.97 |

* I= first season, II= second season.

trends were observed in the second season with slight differences in values. In general, the chemical constituent is concentration-dependent; this may be attributed to the fact that ammonium sulphate may have increased the enzymatic systems responsible for producing these secondary metabolites.

### 3.5. Insecticidal activity of cabbage aphid adults treated with different concentrations of *Iberis amara* extracts

Data presented in **Table (7)** shows that the mortality percentages increased with higher concentrations of various *Iberis amara* extracts. The highest concentration of ethanol extract induced the highest mortality for cabbage aphid (66.67% after 96 h), followed by the two lower ethanol extract concentrations and the highest concentrations of water extract after autolysis and chloroform extracts (all induced 53.33 % mortality). In contrast, hexane extract showed the least effect on this insect.

Here again, the percentages of corrected cumulative mortality of cabbage aphid were in the decreasing order as a result of using various solvents of different polarity: ethanol > water extract after autolysis, and chloroform > water > benzene > ethyl acetate > hexane. It seems that ethanol extracted the polar compounds from *Iberis amara* and induced the highest cabbage aphid mortality. At the same time, the non-polar solvents extract the least amount of polar compounds that are responsible for cabbage aphid mortality.

Several authors studied the effect and the role of different plant extracts on insects. For instance, crucifer feeding insects were not affected by low concentrations of glucosinolates **(Feeny and Rosenberry, 1982).** Glucosinolates breakdown products from *Schouwia purpurea* may possessed a gut irritant and probably cause inhibition of protein enzymes **(Cottee *et al* 1988).** On the same subject, **Hapke *et al* (1997)** tested the efficiency of 30 ppm of Neem Azal-T/S (3 liter/hectare) in different field trials against aphids on sour cherry and bud burst. They found that applications just before and after flowering were the most effective. **Schulz *et al* (1997)** mentioned that different Neem Azal formulations (1% Azadirachtin-A, 51% plant oils) were effective aphicides in laboratory and field trials. Neem Azal sprays to broad bean and apple trees resulted in significant reduction of bean aphid (*Aphis fabae, Scop*) and rosy apple aphid (*Dysaphis plantaginea Pass*). **Ismail *et al* (2002)** studied the influence of different plant extracts from the *Brassicaceae* family such as *Carrichtera annua* L and *Farsetia aegyptia* Turra against the Egyptian cotton leafworm (*Spodoptera littoralis*). They found that aqueous extracts and total glucosinolates of both plants were remarkably toxic against cotton leafworm larvae and exhibited strong anti-feedant effects against $4^{th}$ instar larvae and proved to be the most potent extracts of those tested.

**Ferry *et al* (2004)** reported that many insects are able to detoxify secondary metabolites using cytochrome P540 mono-oxygenases and glutathione S-transferases. These enzymes are induced by exposure to toxic plant secondary compounds; for instance, xanthotoxin (a furanocoumarin compound) induced P450 expression in corn earworm. **Tewary *et al* (2005)** tested the pesticidal activity of plant extracts and essential oils with some known medicinal attributes in order to discover new agents for pest control. Five medicinal plants (*Berberis lycium* L., *Hedera nepalensis* L., *Acorus calamus* L., *Zanthoxylum armatum* L., and *Valeriana jatamansi* L.) were evaluated against some agriculturally important pests (*Aphis cracccivora* Koch, *Tetranychus urticae* Koch, and larvae of *Spodoptera littoralis* Fab, *Plutella xylostella* L., and *Helicoverpa armigera* Hub). Most of the extracts/essential oils were active only against *A. craccivora*. The activity of the test samples was significantly and negatively correlated with contact time. However, at the end of 48 h contact time, all the test samples were almost equal in their efficacy, with LC50 in the range of 55–60 ppm. This is comparable with that of the chemical insecticides (dimethoate and parathion methyl) at 24 h contact time, which had LC50 in the range of 25–51 ppm against *A. craccivora*.

## 4. CONCLUSION

We may conclude that the activity of ethanol extract may attributed to its content of cucurbitacins and glucosinolates since Glucosinolates were present only in ethanol and water extracts of *Iberis amara*. Cucurbitacins were present only in ethanol, benzene, and chloroform extracts. The highest concentration of ethanol extract induced the highest mortality of cabbage aphid. Ammonium sulphate treatments increased the yield of herb, seed, carbohydrate, fixed oils, glucosinolates and phenolic compounds, while sulphur increased the number of branches/plant.

Table 7. Corrected mortality percentages of cabbage aphid adults treated with different concentrations of *Iberis amara* extracts

| Plant extracts | Concentration (% W/V) | Corrected mortality after the indicated period (%) | | | | Corrected cumulative mortality (%) |
|---|---|---|---|---|---|---|
| | | 24h | 48h | 72h | 96h | |
| Water extract after autolysis | 1 | 0.00 | 13.33 | 13.33 | 13.33 | 40.00[d] |
| | 2 | 0.00 | 13.33 | 20.00 | 13.33 | 46.67[c] |
| | 4 | 6.67 | 13.33 | 20.00 | 13.33 | 53.33[b] |
| Ethanol | 1 | 13.33 | 26.67 | 6.67 | 6.67 | 53.33[b] |
| | 2 | 20.00 | 26.67 | 6.67 | 0.00 | 53.33[b] |
| | 4 | 26.67 | 20.00 | 13.33 | 6.67 | 66.67[a] |
| n-Hexane | 1 | 0.00 | 0.00 | 6.67 | 0.00 | 6.67[i] |
| | 2 | 0.00 | 6.67 | 0.00 | 0.00 | 6.67[i] |
| | 4 | 6.67 | 6.67 | 0.00 | 0.00 | 13.33[h] |
| Benzene | 1 | 6.67 | 6.67 | 6.67 | 0.00 | 20.00[g] |
| | 2 | 13.33 | 6.67 | 6.67 | 6.66 | 33.33[e] |
| | 4 | 13.33 | 13.33 | 6.67 | 0.00 | 33.33[e] |
| Chloroform | 1 | 0.00 | 6.67 | 13.33 | 20.00 | 40.00[d] |
| | 2 | 0.00 | 20.00 | 20.00 | 6.67 | 46.67[c] |
| | 4 | 6.67 | 13.33 | 13.33 | 20.00 | 53.33[b] |
| Ethyl acetate | 1 | 0.00 | 6.67 | 6.67 | 6.67 | 20.00[g] |
| | 2 | 0.00 | 6.67 | 13.33 | 6.67 | 26.67[f] |
| | 4 | 0.00 | 13.33 | 13.33 | 0.00 | 26.67[f] |
| Water | 1 | 6.67 | 13.33 | 13.33 | 0.00 | 33.33[e] |
| | 2 | 13.33 | 13.33 | 13.33 | 0.00 | 40.00[d] |
| | 4 | 20.00 | 6.67 | 13.33 | 6.67 | 46.67[c] |
| LSD (5%) | | | | | | 1.44 |

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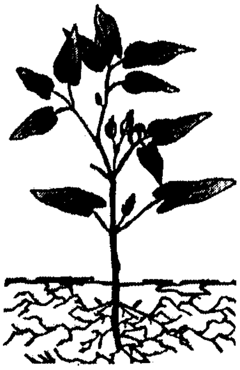
حوليات العلوم الزراعية
جامعة عين شمس ، القاهرة
مجلد(٥٣)، عدد (١)، ٢٤٧-٢٥٧، ٢٠٠٨



# تأثير التسميد الكبريتي على نبات الابرس ودراسة التأثير الابادى الحشري له

**[٢٠]**

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١- قسم النباتات الطبية والعطرية – شعبة الصناعات الصيدلية والدوائية – المركز القومي للبحوث – الجيزة

كان الهدف من الدراسة هو تقييم إنتاجية نبات الابرس المنزرع في الاراضى المصرية ودراسة إمكانية زيادة بعض المركبات الأولية والثانوية عن طريق دراسة تأثير مستويات مختلفة من التسميد الكبريتي. كما تم دراسة إمكانية استخدام نبات الابرس كمبيد نباتي امن وفعال ضد حشرة المن التى تصيب الكرنب.

**يمكن تلخيص أهم النتائج المتحصل عليها كما يلي :**

١. أدى التسميد بواسطة كبريتات البوتاسيوم بجرعة ١٢٠ كجم كبريت لكل هكتار إلى زيادة طول النبات و الوزن الطازج والجاف للأزهار . أما التسميد بواسطة كبريتات الامونيوم بجرعة ١٢٠ كجم كبريت لكل هكتار أدى إلى زيادة عدد الخلفات والوزن الطازج للمجموع الخضرى ومحصول البذور للنبات وكذلك مستويات الكربوهيرات الكلية حيث وصلت إلى ١٣,٩٥% و١٤,٠% والزيت الثابت حيث بلغت النسبة ١٣,٦٢ % و ١٢,٨٥ % للموسم الأول والثاني على التوالي. كما أدى أيضا التسميد بواسطة كبريتات الامونيوم بنفس الجرعة السابقة إلى زيادة كل من الفينولات الكلية والجلوكوسينولات أما التسميد بنفس السماد بجرعة ٩٠ كجم كبريت لكل هكتار أدى إلى زيادة نسبة الكيوكربيتاسينات الكلية في النبات.
٢. المستخلص النباتي الايثانولى لنبات الابرس أعطى أعلى نسبة موت للحشرات الكاملة لمن الكرنب مقارنة بالمستخلصات الأخرى حيث بلغت نسبة الموت إلى ٦٦,٦٧ % بعد ٩٦ ساعة.

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