

## Application of Some Egyptian Medicinal Plant Extracts Against Potato Late and Early Blights

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**Abstract:** Late blight (*Phytophthora infestans*) and early blight (*Alternaria solani*) are the main diseases affecting potato during vegetative growth. Sun – dried samples of nine Egyptian medicinal plant species, i.e. basil leaves (*Ocimum bacilicum*), chilli fruits (*Capsicum frutescens*), eucalyptus leaves (*Eucalyptus globulus*), garlic bulbs (*Allium sativum*), lemon grass leaves (*Cymbopogon citratus*), marjoram leaves (*Majorana hortensis*), onion seeds (*Allium cepa*) and peppermint leaves (*Mentha piperita*) were used. Aqueous extracts of these plants were evaluated against *P. infestans* and *A. solani* *in vitro*, and in field. Plant extracts reduced mycelial growth and inhibited spore germination of both fungal species. The extracts reduced the disease infection with both fungal species comparing with control in detached leaves technique. In winter growing season, the extracts of all medicinal plants reduced the disease severity of late blight. Lemon grass leaves and/or chilli fruit extracts gave the most reduction in late blight disease severity comparing with control. Results also showed that all tested medicinal plant extracts lowered the disease severity of early blight in summer growing season, especially the extracts of lemon grass leaves, garlic bulbs, basil leaves and marjoram leaves, respectively. It is clear that the aqueous extract of lemon grass leaves was the best one in controlling both late and early blights. Also, data indicated that the increasing in some vegetative growth characters (i.e. average stem height and average leaves number per plant) and tubers yield of potato were corresponded with the reduction of disease severity. These results suggested that medicinal plant extracts may be play an important role in controlling the potato blight diseases.

**Key words:** Medicinal plants, aqueous extracts, potato, late blight and early blight diseases

### INTRODUCTION

*Phytophthora infestans* and *Alternaria solani* are the main pathogens causing late and early blight diseases and yield losses in numerous economically important crops such as potato during vegetative growth<sup>[1]</sup>. The development of pest resistance and problems of environmental pollution have accompanied excessive reliance on pesticides. These problems can be avoided or minimized by using the natural material products such as medicinal plant extracts.

Controlling of late blight by plant extracts as components in integrated plant protection was carried out by many workers allover the world. Blaeser and Steiner<sup>[2]</sup> examined the efficacy of 35 plant extracts against *P. infestans* on tomato plants under greenhouse conditions. Of the tested plant extracts, 32% showed efficacies between 50-80%, only 5% of the extracts had an efficacy over 80%. The greatest antifungal effect were achieved with the extracts of *Potentilla erecta* (90%) and *Salvia officinalis* (83%). Extracts from different parts of 25 medicinal plant species were incorporated in soils of potato<sup>[3]</sup>. The development and tuber yield of potatoes and late blight severity on the

leaves were measured to evaluate the impact of these medicinal plants on potato growth. Late blight disease severity was significantly lowered by *Malvae folium*, *Salviae folium* (from *Salvia officinalis*) and *Bardanae radix* (from *Arctium lappa*). Muto *et al.*<sup>[4]</sup> showed that the extracts derived from fresh and dry tissues of 14 plant species were evaluated for activities against *P. infestans* and *A. solani*. Results showed that inhibition of spore germination, mycelial growth and cell proliferation of the plant pathogens varied with plant extracts, microorganisms, and extraction method (hot water and ethanol). Suspensions and extracts of medicinal plants reduced foliar blight of potatoes (*P. infestans*) significantly in wet room experiments<sup>[5]</sup>. The efficacy of finely ground plant material sprayed as aqueous suspensions was comparable or better than the ethanolic extracts.

The effect of 11 different halophytic plant extracts (root, stem, leaf and bark) on the mycelial growth of *A. solani* was studied *in vitro* tests<sup>[6]</sup>. The results showed that the bark and leaf extracts of *Tamarix aphylla*, leaf and stem extracts of *Salsola baryosma*, root and stem extracts of *Atriplex lentiformis* and stem extract of *Haloxylon recurvum* totally inhibited the

mycelial growth of *A. solani*. From eighteen extracts (100% concentration) of different plant families sprayed on infected tomato plants with *A. solani* pathogen, *Prosopis juliflora* and *Cocos nucifera* leaves significantly inhibited fungal spore germination by 91.5 and 90.8%, and mycelial growth by 88.8 and 87.7%, respectively<sup>[7]</sup>. Prasad and Naik.<sup>[8]</sup> evaluated the plant extracts (garlic and onion bulb, neem leaf and *Prosopis* and *Ocimum* leaf extracts) in controlling the *A. solani* pathogen using the poisoned food technique. Garlic bulb and *Prosopis* leaf extracts showed considerable amount of inhibition on the mycelial growth of *A. solani*. *Eucalyptus* sp. leaf extract at 10% concentration inhibited the mycelial growth of *A. solani* under natural and artificial inoculation conditions<sup>[9]</sup>. Also, garlic and neem oils reduced the early blight disease development on tomato compared to the control<sup>[10]</sup>.

This work aimed to determine the efficacy of aqueous extracts of some Egyptian medicinal plant species in suppression the mycelial growth, inhibition the spores germination of both *P. infestans* and *A. solani* *in vitro* tests and reducing the development of infection with pathogenic fungi on detached potato leaves *in vivo* testes. Moreover, evaluate the efficacy of the plant extracts on the development and severity of both late and early blights on the leaves and tuber yield of potato plants, under field conditions.

## MATERIALS AND METHODS

**Pathogens:** For isolation the late and early blight pathogens, naturally infected potato leaves showing the late and early blight symptoms were collected from El-Qanater El-Khairea, Kalubiya governorate, Egypt. The pathogenic fungi were isolated using potato dextrose agar & V8 medium<sup>[11]</sup> and identified in Plant Pathology Department, National Research Centre, Egypt.

**Egyptian Medicinal Plant Material:** Sun – dried samples of nine Egyptian medicinal plant species, i.e. basil leaves (*Ocinum bacilicum*), chilli fruits (*Capsicum frutescens*), eucalyptus leaves (*Eucalyptus globulus*), garlic bulbs (*Allium sativum*), lantana leaves and flowers (*Lantana camara*), lemon grass leaves (*Cymbopogon citratus*), marjoram leaves (*Majorana hortensis*), onion seeds (*Allium cepa*) and peppermint leaves (*Mentha piperita*) collected from organic farm system of Fayoum governorate, Egypt were used.

**Preparation of Aqueous Medicinal Plant Extracts:** For water extraction; 100 grams of each sun-dried medicinal plant material, were separately added to 1000 ml distilled water (1:10 w/v). Then, extracted under cold conditions for 24h<sup>[12]</sup>. In case of garlic; bulbs were cut into small pieces and then macerated by blender<sup>[13]</sup>. Plant extracts were filtered through two

cheese cloth. This concentration (10%), as a crude aqueous extract, was used in the antifungal activity experiments.

**Laboratory Tests:** Antifungal activity of tested aqueous medicinal plant extracts (TAMPE) at concentrations of 2.5, 5.0 and 10.0% against pathogenic fungi, i.e. *P. infestans* and *A. solani* *in vitro* tests was screened.

**a) Effect on Linear Mycelial Growth:** Effect of TAMPE on linear mycelial growth of pathogenic fungi was carried out using hole plate diffusion technique<sup>[14]</sup>. Petri dishes (7 cm diameter) contains 15ml of potato dextrose agar medium (PDA) were used. Then, each Petri dish was inoculated with 5mm disc of each pathogenic fungus in the centre. Three wells of 1cm diameter were made at distance of 1cm surrounded the fungal disc. 100 µL amounts of TAMPE from each concentration were added in each well. Sterile water was added as the control. Three plates were used for each concentration as replicates. Inoculated plates were incubated at 25°C until mycelial growth of fungus covered the surface of medium in control treatment. The antifungal activity of TAMPE was measured and the percentage of linear growth reduction of pathogenic fungi comparing with control was calculated using this formula;

Linear growth reduction (%) =

$$\frac{\text{Growth in control} - \text{Growth in treatment}}{\text{Growth in control}} \times 100$$

**b) Effect on Fungal Spores Germination:** Antifungal activity of TAMPE on spores germination of *P. infestans* (sporangia) and *A. solani* (conidia) was tested using the slide technique<sup>[15]</sup>. The TAMPE were added to dried clean slides as a film. Then, 0.1ml of spores suspension of pathogenic fungi was spread over this films. Control treatment was prepared as a film of sterilized distilled water. Three slides were used as replicates for each concentration. Each slide was placed on glass rod in Petri-dish under moisten conditions and incubated for 24h at 25°C. Four microscopic fields (x = 10 x 40) for each replicated (slide) were used. Spores germination (%) was calculated according to the following formula:

Spores germination (%) =

$$\frac{\text{Spores germination (no.)}}{\text{Total spores (no.)}} \times 100$$

**c) Detached Leaf Technique (*in vivo*):** Discs (1.5 cm diameter) of healthy detached leaves of potato, on cotton layer covered with filter paper moistened with sterile distilled water, in Petri-dishes were used in this study. Inoculation with *P. infestans* and *A. solani* spores suspension on leaf discs was carried out according to the laboratory technique reported by Townsend and Heuberger<sup>[16]</sup>. Ten leaf discs/Petri-dish (9 cm diameter) of potato were used. Three Petri-dishes (30 leaf discs) were used as replicates for each concentration. Each treatment sprayed with each concentration of TMPAE, separately, then inoculated with pathogenic fungus. For control treatment, leaf discs were sprayed with distilled water and disease incidence determined after 7 days from inoculation. Reduction (%) of disease incidence was calculated in relation to the control.

**Field Experiments:** Potato tubers (*Solanum tuberosum* L.) cv. Diamond were planted in the experimental farm of National Research Centre (NRC) at El-Qanater El-Khairea, Kalubiya governorate, Egypt.

The antifungal activity of the tested aqueous medicinal plant extracts (TAMPE), against late and /or early blight diseases in potato plants, was examined in two separate field experiments. Each field experiment consisted of small-plots 4m<sup>2</sup> (2x2m) in area with three replicates (plots) for each plant extract treatment as well as control<sup>[17]</sup>. Each plot comprised of 4 lines with 50 cm between holes. Each experiment was designed in a complete randomized block design. In the first experiment, whole potato tuber were sown (one tuber/hole) in winter growing season (October-January) of 2005/2006 for testing the antifungal activity of TAMPE against late blight disease. In the second experiment, tuber pieces containing one or more sprouts (one piece/hole) were sown in summer growing season (February-May) of 2006 for testing the TAMPE against early blight disease.

**Aqueous Plant Extract Application:** All tested medicinal plant extracts were applied as foliar application at two spraying times. The first spray was at 3-4 leaf growth stage of plant. The second was applied after 7 days from the first application<sup>[18]</sup>.

**Disease Index:** Disease index (severity) of late and early blight diseases were recorded for different plant extract treatments. After 70 days of planting, ten plants were chosen from each replicate per treatment, then five leaves of each plant were used to determine the disease severity<sup>[18]</sup>. Infected leaves were classified into five categories (0,1,2,3 and 4) according to blighted area of leaves<sup>[19]</sup>, i.e. no infected leaves; 25% or less; 26-50%; 51-75% and 76-100%, respectively. Disease index percentage was calculated according to the

following formula:

$$\text{Disease index (\%)} = \frac{(n \times r_1) - (n \times r_4)}{4N} \times 100$$

n = Number of infected leaves

r<sub>1</sub> – r<sub>4</sub> = Category number.

N = Total examined leaves.

**Vegetative Characters:** A random sample of ten plants were taken at 70 days after planting from each medicinal plant extract treatment, separately, to determine the average of stem height (cm) and average number of leaves per plant<sup>[18, 20]</sup>.

**Determination of Tuber Yield:** After harvest, total tuber yield per plant (g) and/or per feddan (ton) in different treatments of medicinal plant extract application was determined.

**Statistical Analysis:** The obtained results were statistically analyzed according to Steel and Torrie<sup>[21]</sup>. L.S.D. test was used to compare means of treatments at 5% levels of significance.

## RESULTS AND DISCUSSIONS

### Results:

**Effect on Fungal Spores Germination:** Results in Table (1) showed that all treatments significantly decreased the spores germination (%) of *P. infestans* and *A. solani* comparing with the control. Aqueous plant extracts as film treatments were more effective in reducing the spores germination of tested pathogenic fungi. The values of spores germination were significantly decreased by increasing the concentrations of TAMPE from 2.5 to 10.0%. The aqueous extracts reduced the spores germination (%) of *P. infestans* from 30 to 56%, 41 to 72%, and 58 to 81% and *A. solani* from 23 to 46%, 36 to 53% and 47 to 68% at concentrations of 2.5%, 5.0 and 10.0%, respectively. Data showed that less value of spores germination (%) of *P. infestans* was obtained with extract of lantana leaves & fruits followed by extracts of lemon grass leaves, basil leaves, onion seeds, peppermint leaves, marjoram leaves garlic bulbs, eucalyptus leaves, and chilli fruits, respectively. They gave spores germination (%) were 24.8, 28.8, 31.5, 33.1, 34.2, 36.9, 38.9, 34.9 and 45.6%, respectively. The spores germination (%) of *A. solani* under different treatment conditions were 39.8, 40.9, 43.9, 44.9, 45.2, 46.0, 49.8, 49.8, and 53.1% with the extracts of basil leaves, lantana leaves & fruits, garlic bulbs, chilli fruits, eucalyptus leaves, lemon grass leaves, onion seeds, peppermint leaves, and marjoram leaves, respectively (Table, 1). It is clear that the TAMPE

**Table 1:** Effect of different concentrations of aqueous medicinal plant extracts on spore germination of *P. infestans* and *A. solani* *in vitro* after incubation at 25°C and 100% RH.

| Fungi                   | Spores germination (%) |       |      |       |       |       |      |      |                  |      |       |      |       |      |      |      |            |
|-------------------------|------------------------|-------|------|-------|-------|-------|------|------|------------------|------|-------|------|-------|------|------|------|------------|
|                         | <i>P. infestans</i>    |       |      |       |       |       |      | Mean | <i>A. solani</i> |      |       |      |       |      |      | Mean | Grand mean |
|                         | 2.5%                   |       | 5.0% |       | 10.0% |       |      |      | 2.5%             |      | 5.0%  |      | 10.0% |      |      |      |            |
|                         | G.%                    | Red.% | G.%  | Red.% | G.%   | Red.% |      | G.%  | Red.%            | G.%  | Red.% | G.%  | Red.% |      |      |      |            |
| Basil leaves            | 48.7                   | 38    | 30.0 | 62    | 15.7  | 80    | 31.5 | 47.4 | 44               | 45.2 | 46    | 26.9 | 68    | 39.8 | 35.7 |      |            |
| Chilli fruits           | 55.0                   | 30    | 47.0 | 41    | 34.7  | 56    | 45.6 | 45.7 | 46               | 44.7 | 47    | 44.5 | 47    | 44.9 | 45.3 |      |            |
| Eucalyptus leaves       | 51.3                   | 35    | 43.0 | 46    | 37.3  | 53    | 43.9 | 61.0 | 28               | 44.2 | 48    | 30.4 | 64    | 45.2 | 44.5 |      |            |
| Garlic bulbs            | 49.7                   | 37    | 37.7 | 52    | 28.7  | 64    | 38.9 | 46.5 | 45               | 46.3 | 45    | 39.0 | 54    | 43.9 | 41.3 |      |            |
| Lantana leaves & fruits | 37.0                   | 53    | 22.0 | 72    | 15.3  | 81    | 24.8 | 46.5 | 45               | 39.3 | 53    | 36.8 | 56    | 40.9 | 32.9 |      |            |
| Lemon grass leaves      | 34.7                   | 56    | 27.7 | 65    | 24.0  | 70    | 28.8 | 58.3 | 31               | 41.9 | 50    | 39.7 | 53    | 46.6 | 37.7 |      |            |
| Marjoram leaves         | 39.3                   | 50    | 38.0 | 52    | 33.3  | 58    | 36.9 | 65.2 | 23               | 50.0 | 41    | 44.1 | 48    | 53.1 | 45.0 |      |            |
| Onion seeds             | 47.0                   | 41    | 34.0 | 57    | 18.3  | 77    | 33.1 | 64.6 | 23               | 47.8 | 43    | 36.9 | 56    | 49.8 | 41.2 |      |            |
| Peppermint leaves       | 47.0                   | 41    | 37.0 | 53    | 18.7  | 76    | 34.2 | 57.1 | 32               | 53.6 | 36    | 38.8 | 54    | 49.8 | 42.0 |      |            |
| Control                 | 79.0                   |       |      |       |       |       |      | 84.2 |                  |      |       |      |       |      |      |      |            |

\* Reduction relative to the control treatment:  
L.S.D. 0.05

|             |       |          |       |       |       |
|-------------|-------|----------|-------|-------|-------|
| Extract (E) | = 2.8 | Conc (C) | = 1.6 |       |       |
| Fungi (F)   | = 1.3 | ExC      | = 4.9 | ExFxC | = 6.9 |
| ExF         | = 4.6 | FxC      | = 2.3 |       |       |

were the most effective in reducing the spores germination of *P. infestans* than *A. solani*.

**Effect on Linear Mycelial Growth:** Effect of the TAMPE on the linear mycelial growth of pathogenic fungi, i.e. *P. infestans* and *A. solani* *in vitro* tests is showed in Table (2). Results indicated that all treatments were positively effective in reducing the linear mycelial growth of two pathogenic fungi, generally, comparing with the control. The percentage values of reduction of mycelial growth showed increase with increasing the concentration of TAMPE from 2.5 to 10.0% (Table, 2). Results indicated that the TAMPE showed the highly effect on reducing the mycelial growth of *A. solani* comparing with *P. infestans*. The highly inhibition of mycelial growth of *P. infestans* was obtained with lemon grass leaves followed by garlic bulbs, onion seeds, basil leaves, eucalyptus leaves, peppermint leaves, marjoram leaves, chilli fruits and lantana leaves & Fruits, respectively. They gave the values of mycelial growth reduction (%) 68.9, 61.0, 56.1, 55.2, 53.6, 48.3, 47.0, 46.9 and 46.2%, respectively. Date also showed that the lemon grass leaves extract highly reduced the mycelial growth of *A. solani*, followed by peppermint leaves, onion seeds, marjoram leaves, lantana leaves & fruits; gralic bulbs, basil leaves, eucalyptus leaves, and chilli leaves, respectively. They gave values of growth

reduction (%) of 62.3, 62.2, 62.1, 61.8, 57.2, 56.8, 53.6, 53.3 and 44.8%, respectively.

**Effect on Disease Incidence *in vivo*:** Detached leaves of potato plants were artificially inoculated with spores suspension of *P. infestans* and *A. solani*, separately, and then sprayed with nine aqueous medicinal plant extracts, 24 hrs before inoculation. Data in Table (3) showed that TAMPE decreased values of disease infection. The percentage of detached potato leaves infected with each tested pathogenic fungi decreased by increasing the concentration of TAMPE from 2.5 to 10.0%. The values of disease infection with fungus of *P. infestans* were 18.9, 27.8, 31.1, 32.2, 34.4, 37.8, 38.9, 41.1 and 42.2% with extracts of lemon grass leaves peppermint leaves, basil leaves, marjoram leaves, onion seeds, garlic bulbs, chilli fruits, eucalyptus leaves and lantana leaves & fruits, respectively. The percentage of disease infection with *A. solani* on detached leaves were 22.2, 22.2, 23.3, 24.4, 27.8, 32.2, 32.2, 36.7, and 36.7% with extracts of chilli fruits, garlic bulbs, lemon grass leaves, basil leaves, lantana leaves & fruits, marjoram leaves, eucalyptus leaves, onion seeds and peppermint leaves, respectively. Data showed that the TAMPE reduced the disease infection with *A. solani* more than *P. infestans*. The disease infection with *P. infestans* were

**Table 2:** Effect of different concentrations of aqueous medicinal extracts on linear mycelial growth of *P. infestans* and *A. solani* after 7 days incubation at 25°C.

| Fungi<br>Plant extracts | Reduction (%) of linear mycelial growth |                |       |      |                  |      |       |                 | Grand mean |  |
|-------------------------|---|----------------|-------|------|------------------|------|-------|-----------------|------------|--|
|                         | <i>P. infestans</i>                     |                |       | Mean | <i>A. solani</i> |      |       | Mean            |            |  |
|                         | 2.5%                                    | 5.0%           | 10.0% |      | 2.5%             | 5.0% | 10.0% |                 |            |  |
| Basil leaves            | 43.6                                    | 50.7           | 71.2  | 55.2 | 45.2             | 54.1 | 61.4  | 53.6            | 54.4       |  |
| Chilli fruits           | 44.3                                    | 44.3           | 52.1  | 46.9 | 37.1             | 40.5 | 56.9  | 44.8            | 45.9       |  |
| Eucalyptus leaves       | 43.3                                    | 54.1           | 63.3  | 53.6 | 43.1             | 53.6 | 63.1  | 53.3            | 53.5       |  |
| Garlic bulbs            | 55.5                                    | 56.4           | 71.2  | 61.0 | 44.5             | 58.6 | 67.4  | 56.8            | 58.9       |  |
| Lantana leaves & fruits | 38.6                                    | 43.6           | 58.1  | 46.8 | 48.6             | 56.0 | 66.9  | 57.2            | 52.0       |  |
| Lemon grass leaves      | 66.4                                    | 69.1           | 71.2  | 68.9 | 52.1             | 64.3 | 70.5  | 62.3            | 65.6       |  |
| Marjoram leaves         | 40.7                                    | 45.5           | 54.8  | 47.0 | 53.1             | 61.7 | 70.5  | 61.8            | 54.4       |  |
| Onion seeds             | 46.7                                    | 56.0           | 65.5  | 56.1 | 53.8             | 62.9 | 69.5  | 62.1            | 59.1       |  |
| Peppermint leaves       | 44.1                                    | 50.2           | 50.5  | 48.3 | 53.8             | 62.4 | 70.5  | 62.2            | 55.3       |  |
| Mean                    | 47.0                                    | 52.2           | 62.0  | 53.7 | 47.9             | 57.1 | 66.3  | 57.1            | -          |  |
| L.S.D. 0.05             |   |                |       |      |                  |      |       |                 |            |  |
| Extract (E) = 2.5       |   | E x F = 3.6    |       |      | E x C = N.S      |      |       | E x F x C = N.S |            |  |
| Fungi (E) = 1.2         |   | Conc (C) = 1.5 |       |      | F x C = 2.1      |      |       |                 |            |  |

**Table 3:** Effect of spraying with different concentration of aqueous medicinal plant extracts on late and early blights incidence on detached potato leaves, artificially inoculated with *P. infestans* and *A. solani* spores.

| Fungi<br>Plant extracts | Disease incidence (%) on sprayed leaves at |       |       |       |       |       |       |                  |       |       |       |       |       |       | Grand mean |
|-------------------------|--|-------|-------|-------|-------|-------|-------|------------------|-------|-------|-------|-------|-------|-------|------------|
|                         | <i>P. infestans</i>                        |       |       |       |       |       | Mean  | <i>A. solani</i> |       |       |       |       |       | Mean  |            |
|                         | 2.5%                                       |       | 5.0%  |       | 10.0% |       |       | 2.5%             |       | 5.0%  |       | 10.0% |       |       |            |
|                         | Inc.%                                      | Red.% | Inc.% | Red.% | Inc.% | Red.% | Inc.% | Red.%            | Inc.% | Red.% | Inc.% | Red.% | Inc.% | Red.% |            |
| Basil leaves            | 43.3                                       | 48    | 26.7  | 68    | 23.3  | 72    | 31.1  | 33.3             | 58    | 26.7  | 67    | 13.3  | 84    | 24.4  | 27.8       |
| Chilli fruits           | 53.3                                       | 36    | 36.7  | 56    | 26.7  | 68    | 38.9  | 43.3             | 46    | 13.3  | 83    | 10.0  | 88    | 22.2  | 30.6       |
| Eucalyptus leaves       | 53.3                                       | 36    | 36.7  | 56    | 33.3  | 60    | 41.1  | 43.3             | 46    | 33.3  | 58    | 20.0  | 75    | 32.2  | 36.7       |
| Garlic bulbs            | 50.0                                       | 40    | 36.7  | 56    | 26.6  | 68    | 37.8  | 36.7             | 54    | 16.7  | 79    | 13.3  | 84    | 22.2  | 30.0       |
| Lantana leaves & fruits | 56.7                                       | 32    | 36.7  | 56    | 33.3  | 60    | 42.2  | 46.7             | 42    | 23.3  | 71    | 13.3  | 84    | 27.8  | 35.0       |
| Lemon grass leaves      | 26.7                                       | 68    | 16.7  | 80    | 13.3  | 84    | 18.9  | 33.3             | 58    | 23.3  | 71    | 13.3  | 84    | 23.3  | 21.1       |
| Marjoram leaves         | 36.7                                       | 56    | 33.7  | 60    | 26.7  | 68    | 32.2  | 43.3             | 46    | 36.7  | 54    | 16.7  | 79    | 32.2  | 32.2       |
| Onion seeds             | 43.3                                       | 48    | 36.7  | 56    | 23.3  | 72    | 34.4  | 60.0             | 25    | 26.7  | 67    | 23.3  | 71    | 36.7  | 35.6       |
| Peppermint leaves       | 33.3                                       | 60    | 26.7  | 68    | 23.3  | 72    | 27.8  | 50.0             | 38    | 40.0  | 50    | 20.0  | 75    | 36.7  | 32.3       |
| Control                 | 83.3                                       |       |       |       |       |       | 80.0  |                  |       |       |       |       |       |       |            |

\*Reduction relative to the control treatment:

L.S.D. 0.05

|             |       |          |        |       |       |
|-------------|-------|----------|--------|-------|-------|
| Extract (E) | = 4.7 | Conc (C) | = 2.7  |       |       |
| Fungi (F)   | = 2.2 | ExC      | = N.S. | ExFxC | = N.S |
| ExF         | = 6.7 | FxC      | = 5.3  |       |       |

from 32 to 68 %; 50 to 68%, and 60 to 84% , and the disease infection with *A. solani* were from 25 to 58%, 50 to 83% and 71 to 88% at concentrations of

2.5, 5.0 and 10.0%, respectively (Table, 3). It is clear that the lemon grass leaf extract gave the more reduction of disease infection

**Table 4:** Late blight severity (%) in potato plants treated with aqueous medicinal plant extracts during winter growing season (October-January of 2005-2006).

| Plant extracts           | Disease Severity (%) | Reduction (%) |
|--------------------------|----------------------|---------------|
| Basil leaves.            | 23.3                 | 60.0          |
| Chilli fruits.           | 15.5                 | 73.4          |
| Eucalyptus leaves.       | 35.0                 | 40.0          |
| Garlic bulbs.            | 26.7                 | 54.2          |
| Lantana leaves & fruits. | 25.0                 | 57.1          |
| Lemon grass leaves.      | 13.3                 | 77.2          |
| Marjoram leaves.         | 21.7                 | 62.8          |
| Onion seeds.             | 51.7                 | 11.3          |
| Peppermint leaves.       | 35.0                 | 40.0          |
| Untreated (control).     | 58.3                 | -             |
| L.S.D. 0.05              | 16.6                 | -             |

**Table 5:** Early blight severity (%) in potato plants treated with aqueous medicinal plant extracts during summer growing season (February-May of 2006).

| Plant extracts           | Disease Severity (%) | Reduction (%) |
|--------------------------|----------------------|---------------|
| Basil leaves.            | 11.7                 | 78.1          |
| Chilli fruits.           | 25.0                 | 53.1          |
| Eucalyptus leaves.       | 35.0                 | 34.3          |
| Garlic bulbs.            | 10.0                 | 81.2          |
| Lantana leaves & fruits. | 18.3                 | 65.7          |
| Lemon grass leaves.      | 10.0                 | 81.2          |
| Marjoram leaves.         | 13.3                 | 75.1          |
| Onion seeds.             | 30.0                 | 43.7          |
| Peppermint leaves.       | 23.3                 | 56.3          |
| Untreated (control).     | 53.3                 | -             |
| L.S.D. 0.05              | 16.2                 | -             |

of pathogenic fungi, followed by basil leaves, garlic bulbs, chilli fruits, marjoram leaves, peppermint leaves, lantana leaves & fruits, onion seeds and eucalyptus leaves, where the grand mean of disease infection (%) were 21.1, 27.8, 30.0, 30.6, 32.2, 32.3, 35.0, 35.6 and 36.7%, respectively.

**Effect on Disease Severity in Field:** Disease severity (%) of late blight on potato plants in the field, when treated with the tested Egyptian medicinal plant extracts during winter growing (October-January of 2005-2006) season are shown in Table (4). Data showed that all treatments significantly reduced the disease severity of late blight disease comparing with the control treatment, except the extract of onion seeds. Results indicated that the disease severity of late blight ranged from 13.3 to 51.7% in the plant extracts treatments, while in the control treatment it was 58.3%. It is obvious that the extract of lemon leaves was the most effective against late blight disease, followed by chilli fruits, marjoram leaves, basil leaves, lantana leaves & fruits, garlic bulbs, eucalyptus leaves, peppermint leaves and onion seeds, respectively. They reduced the disease severity by 77.2, 73.4, 62.8, 60.0, 57.1, 54.2, 40.0, 40.0 and 11.3%, respectively.

Data in Table (5) show the disease severity of early blight on potato plants during summer growing (February-May of 2006) season at field as affected by the tested medicinal plant extracts. It is clear that all plant extracts treatments significantly reduced the

disease severity of early blight comparing with the control treatment. The disease severity of early blight ranged from 10.0 to 35.0% with plant extract treatments, while in control treatment it was 53.3%. The best control against early blight disease was obtained by the extracts of lemon grass leaves, and garlic bulbs, followed by extracts of basil leaves, marjoram leaves, lantana leaves & fruits, peppermint leaves, chilli fruits, onion seeds, and eucalyptus leaves, respectively. They reduced the disease severity by 81.2, 81.2, 78.1, 75.1, 65.7, 56.3, 53.1, 4.7 and 53.1, respectively.

**Effect on Some Vegetative Characters:** In winter growing season, the efficacy of water extract (10%, w/v) of each medicinal plant on some vegetative characters of potato plants, i.e. stem height and number of leaves per plant is shown in Table (6). Results showed that the extract treatments gave the average stem height ranged from 42.3 to 50.3 cm., while the average number of leaves per plant ranged from 9.4 to 12.5 comparing with 38.3 cm and 7.7 leaves in the control treatment, respectively. All extract treatments significantly increased the stem height of potato plants, except extracts of marjoram leaves and peppermint leaves. It is clear that the tested plant extracts showed that the increasing in plant height of potato plant was between 10.4 to 31.3% (Table, 6). The significant increase in number of leaves per plant was recorded with extracts of lantana leaves & fruits and peppermint leaves, respectively, comparing with the control.

In summer growing season, data in Table (7) showed that the average of stem height of potato plants ranged from 31.0 to 42.0 cm, while the average of leaves per stem ranged from 7.8 to 11.1 comparing the control plants. Results showed that the plant extracts increased the stem height between 10.7 to 50.0% (Table, 7). The greatest stem height was achieved with the extract of garlic bulbs (42.0 cm) and lemon grass leaves (40.0 cm). Data in Table (7) indicated that all extracts significantly increased the potato stem high, except extract of marjoram leaves. The tested extracts significantly produced the number of leaves per plant comparing with the control, except extracts of onion seeds, eucalyptus leaves and lemon grass leaves. The garlic bulb gave the best number of leaves per plant.

**Effect on Potato Tuber Yield:** Effect of extracts from different 9 medicinal plant species on tuber yield of potatoes during winter growing season are shown in Table (8). Results showed that the tuber yield of potatoes ranged from 298.4 to 525.9 g, when sprayed the aqueous extracts of the tested medicinal plants comparing with the untreated plants (269.9 g).

**Table 6:** Influence of tested aqueous medicinal plant extracts on some vegetative characters of potato during October-January of 2005/2006 season.

| Plant Extracts           | Vegetative characters      |            |                            |            |
|--------------------------|----------------------------|------------|----------------------------|------------|
|                          | Average of stemheight (cm) | Increase % | Average No. of leaves/stem | Increase % |
| Basil leaves.            | 48.7                       | 27.2       | 9.4                        | 22.1       |
| Chilli fruits.           | 45.0                       | 17.5       | 10.9                       | 41.6       |
| Eucalyptus leaves.       | 47.7                       | 24.5       | 9.5                        | 23.4       |
| Garlic bulbs.            | 50.3                       | 31.3       | 9.8                        | 27.3       |
| Lantana leaves & fruits. | 44.7                       | 16.7       | 12.5                       | 62.3       |
| Lemon grass leaves.      | 46.0                       | 20.1       | 9.9                        | 28.6       |
| Marjoram leaves.         | 42.7                       | 11.5       | 9.6                        | 24.7       |
| Onion seeds.             | 45.7                       | 19.3       | 10.2                       | 32.5       |
| Peppermint leaves.       | 42.3                       | 10.4       | 12.3                       | 59.7       |
| Untreated (control).     | 38.3                       | -          | 7.7                        | -          |
| L.S.D. 0.05              | 5.4                        | -          | 3.6                        | -          |

**Table 7:** Influence of tested aqueous medicinal plant extracts on some vegetative characters of potato plants during February-May of 2006 season.

| Plant Extracts           | Vegetative characters      |            |                            |            |
|--------------------------|----------------------------|------------|----------------------------|------------|
|                          | Average of stemheight (cm) | Increase % | Average No. of leaves/stem | Increase % |
| Basil leaves.            | 35.0                       | 25.0       | 9.3                        | 38.8       |
| Chilli fruits.           | 37.3                       | 33.2       | 10.7                       | 59.7       |
| Eucalyptus leaves.       | 36.0                       | 28.6       | 8.0                        | 19.4       |
| Garlic bulbs.            | 42.0                       | 50.0       | 11.1                       | 65.7       |
| Lantana leaves & fruits. | 37.0                       | 32.1       | 10.0                       | 49.3       |
| Lemon grass leaves.      | 40.0                       | 42.9       | 7.8                        | 16.4       |
| Marjoram leaves.         | 31.0                       | 10.7       | 9.2                        | 37.3       |
| Onion seeds.             | 32.7                       | 16.8       | 8.5                        | 26.9       |
| Peppermint leaves.       | 34.7                       | 23.9       | 10.2                       | 52.2       |
| Untreated (control).     | 28.0                       | -          | 6.7                        | -          |
| L.S.D. 0.05              | 4.2                        | -          | 2.4                        | -          |

**Table 8:** Influence of tested aqueous medicinal plant extracts on tuber yield of potato plants during October-January 2005/2006 season.

| Plant Extracts           | Tuber yield / plant (g) |              | Calculated tuber yield / feddan (ton) |              |
|--------------------------|-------------------------|--------------|---------------------------------------|--------------|
|                          | Average                 | Increase (%) | Average                               | Increase (%) |
| Basil leaves.            | 430.8                   | 59.6         | 9.1                                   | 59.7         |
| Chilli fruits.           | 525.9                   | 94.8         | 11.1                                  | 94.7         |
| Eucalyptus leaves.       | 393.7                   | 45.9         | 8.3                                   | 45.6         |
| Garlic bulbs.            | 424.6                   | 57.3         | 8.9                                   | 56.1         |
| Lantana leaves & fruits. | 369.9                   | 37.1         | 7.8                                   | 36.8         |

**Table 8:** Continued.

|                      |       |      |      |      |
|----------------------|-------|------|------|------|
| Lemon grass leaves.  | 523.6 | 94.0 | 11.0 | 93.0 |
| Marjoram leaves.     | 366.9 | 35.9 | 7.7  | 35.1 |
| Onion seeds.         | 298.4 | 10.6 | 6.3  | 10.5 |
| Peppermint leaves.   | 407.0 | 50.8 | 8.6  | 50.9 |
| Untreated (control). | 269.9 | -    | 5.7  | -    |
| L.S.D. 0.05          | 37.6  | -    | 1.4  | -    |

**Table 9:** Influence of tested aqueous medicinal plant extracts on tuber yield of potato plants during February-May of 2006 season.

| Plant Extracts           | Tuber yield / plant (g) |              | Calculated tuber yield / feddan (ton) |              |
|--------------------------|-------------------------|--------------|---------------------------------------|--------------|
|                          | Average                 | Increase (%) | Average                               | Increase (%) |
| Basil leaves.            | 403.3                   | 64.3         | 8.5                                   | 63.5         |
| Chilli fruits.           | 317.2                   | 29.2         | 6.7                                   | 28.9         |
| Eucalyptus leaves.       | 253.1                   | 3.1          | 5.3                                   | 1.9          |
| Garlic bulbs.            | 429.3                   | 74.9         | 9.0                                   | 73.1         |
| Lantana leaves & fruits. | 372.6                   | 51.8         | 7.8                                   | 50.0         |
| Lemon grass leaves.      | 483.5                   | 96.9         | 10.2                                  | 96.2         |
| Marjoram leaves.         | 372.5                   | 51.7         | 7.8                                   | 50.0         |
| Onion seeds.             | 327.8                   | 33.5         | 6.9                                   | 32.7         |
| Peppermint leaves.       | 295.6                   | 20.4         | 6.2                                   | 19.2         |
| Untreated (control).     | 245.5                   | -            | 5.2                                   | -            |
| L.S.D. 0.05              | 38.7                    | -            | 0.8                                   | -            |

The water extracts of tested medicinal species significantly increased tuber yield of potatoes per plant, except extract of onion seeds, comparing with the control. The highest yields obtained with extracts of chilli fruits and lemon grass leaves, followed by extracts of basil leaves, garlic bulbs, peppermint leaves, eucalyptus leaves, lantana leaves & fruits, marjoram leaves and onion seeds, respectively. They increased the potato tuber yields per plant about 94.8, 94.0, 59.6, 57.3, 50.8, 45.9, 37.1, 35.9 and 10.6%, respectively. The yield production followed the same trend observed in the reduction of disease severity.

Influence of the tested aqueous medicinal plant extracts on the tuber yield of potatoes during summer growing season are shown in Table (9). Spars of plant extracts produced potato tuber yield per plant ranged from 253.1 to 483.5 g, comparing with 245.5 g/plant in the control treatment. Results showed that all treatments significantly increased the tuber yields, except eucalyptus leaves extract, comparing with the control. The greatest tuber yield was obtained with extracts of lemon grass leaves and garlic bulbs. Also, the yield production in summer growing season followed the same trend observed in reduction disease

severity of early blight. Data showed that the increasing in potato tuber yields ranged from 3.1 to 96.9% (Table, 9).

**Discussion:** Late (*P. infestans*) and early (*A. solani*) blights are the main diseases affecting potato during vegetative growth<sup>[1]</sup>. The development of diseases resistance and problems of environmental pollution make the use of chemical pest management is problematic<sup>[22]</sup>. Avoiding or minimizing the pesticide residues is required in the marketable products of potatoes. Therefore, one important aspect is the development of alterative control treatments based on plant extracts<sup>[23]</sup>.

Several reports mentioned that the plant extracts of medicinal species play an important role in controlling the late and/or early pathogens *in vitro* and *in vivo* testes<sup>[22-25]</sup>. Results this work showed that the TAMPE inhibited spores germination and reduced the linear mycelial growth of both *P. infestans* and *A. solani in vitro* and *in vivo* tests. The inhibitory effect of the tested extracts might be due to natural bioactive materials present in these extracts<sup>[27 - 28]</sup>. Lemon grass leaves extract gave the best result to inhibit the spore germination and reduce the mycelial



growth of two pathogenic fungi. *In vivo* tests, detached leaf technique showed that the TAMPE decreased the disease infection with both *P. infestans* and *A. solani*. It is clear that, the efficacy of plant extracts in controlling the late and early blight [23, 29]. So, this work is aimed to test the effect water extracts of the medicinal plant species on controlling the late and early blights in field application.

The present experiments showed that the aqueous extracts of the tested medicinal plants (except onion seeds) significantly reduced the disease severity of late blight during winter growing season. The extracts of lemon grass leaves and/or chilli fruits lowered the disease severity of late blight as compared with the control plants. Data also indicated that the tested medicinal plant extracts significantly reduced the disease severity of early blight in summer growing season. The greatest reduction in disease severity of early blight was obtained with the aqueous extracts of lemon grass leaves, garlic bulbs, basil leaves and marjoram leaves. Such results are in accordance with pervious work on the role of plant extracts in fungal diseases control which provided successful control against late and/or early blights *in vitro* and *in vivo* tests [5,26,30].

Our results agree with those reported by Krebs *et al.* [5]. They mentioned that the water extracts of medicinal plants reduced foliar blight of potato plants better than ethanol extracts. Also, with aqueous suspension the environment pollution with solvents (ethanol) during the field application is reduced. The efficacy of medicinal plant species may be due to induce the resistance system in treated plants [31] or cause a delay in the development of infection in early growth stage by inhibition the mycelial growth of pathogen [3].

All medicinal plant extract treatments improved some vegetative characters, i.e. average of stem height and average number of leaves per potato plant as compared with control plants. Also, our results indicated that the tested medicinal plant extracts improved the yield of potatoes [18, 32]. This trend may be used to reduce the disease severity. In conclusion, our results are in the same trend of the pervious studies on control the late and/ or early blights *in vitro* and *in vivo* tests using the plant extracts.

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