Factors Affecting the Thermal Fogger for Controlling of “Parlatoria Blanchardi” on Date-Palm Trees

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ABSTRACT

The aim of this research is to study factors affecting thermal fogger for controlling “Parlatoria Blanchardi” on the date-palm trees. The outlet tube of the tested fogger was modified by addition tube of 1000 mm length with 30.8 mm diameter. So, the total resonator length increased to 1740 mm to suit with palm tree heights and easy fog flow. The studied variables included fogger conditions (mobile fogger by human and fogger attached to tricycle), control materials (Malathion, Mineral oil (KZ); “KZ+malathion” and without insecticide), tricycle forward-speeds (0.6, 0.8, 1.0 and 1.2 m/s), the fog angles (30°, 45° and 60°) and resonator length (74 and 174 cm). The maximum control efficiencies for the nymphs and adult insect were 84.7 and 95.81% respectively, using fog angle of 45°, resonator length of 174 cm, control material of “KZ” and forward-speed of 0.6 m/s. The fogger capacities were 93, 108, 120 and 132 trees per hour using tricycle forward-speeds of 0.6, 0.8, 1.0 and 1.2 m/s respectively. Using optimum fog angle of 45° with resonator length of 174 cm, the maximum yield of date-palm fruit is 109.6 kg/tree at forward-speed of 0.6 m/s and “KZ” controlling material. Meanwhile, the minimum yield recorded 88.2 kg/tree was obtained under forward-speed of 1.2 m/s and “Malathion” control material. Under fog angle 45° and approximately and resonator length of 174 cm, the minimum range of hourly, operation and production costs of using the fogger attached to tricycle at forward speed range of 0.6-1.2 m/s were 24.6-26.2 L.E./h, 0.20-0.26 L.E./tree and 1.96-2.41 L.E./Mg fruit for “KZ”.

Keywords: Date-palm trees, thermal fogger, controlling material, resonator length and “Parlatoria Blanchardi”

INTRODUCTION

Thermal fogger or portable thermal fogging machine is known for its superior efficiency compared to other machines. As it has the smallest micron size. The SM600 device sprays a 5 liter formulation liquid as “1,590,000,000,000” particles with a diameter of 15 µm. Hence, the possibility of sprayed particles containing insecticide come in contact with an insect is higher compared to other machines. It needs to be underlined it is critical to know baseline droplet and spray characteristics for the equipment used. Fugging machines generally fall into 1 type and droplet sizes of thermal foggers are generally 15 µm or less, the exact size depend on several factors, including the particular nature of solvent used in mixture (Mabbot 2003, 2004, 2006). Thermal fogging equipment varies with regard to equipment type and droplet sizes generated (WHO 1990, 2003 and 2006). The cortical insect (parlatoria) affects fronds, locusts, lowers and fruits. Severe injury causes dryness and death of fronds, which leads to a general weakness of the date palm and its decrease dates quality. It is possible to identify insect infestation through scales that spread on fronds, wicker and fruits.

Cerruto et al. (2009) showed there in non-significant differences for mean foliar deposition between the two spray lances and the two working pressures. However, the higher...
pressure improved significantly the deposit into the internal layer of the canopy (+57%), whereas the Yamaho C-6 spray lance produced a higher deposit on the external layer at any pressure. The greatest differences between external and internal layer were mainly concentrated in the middle and high parts of the canopy.

Fore there more, amount of the pesticide losses depend on many factors, such as the kind of equipment, the application volume, and the spray quality (Rincón, 2020).

Sánchez et al. (2011) stated that the lack of uniformity from hand-held gun sprayers is the combined result of the effect of insufficient penetration in the canopy, heavy losses to the soil from the leaf, and insufficient deposition on the axial side of the leaves. These results confirm that the use of a higher volume or pressure cannot ensure the best results and insufficient control of pests, farmers usually spray more frequently using the same pesticide and a larger spraying volume, increasing environmental pollution, operator exposure risks and the risk of plant resistance development.

A correct treatment should have a deposition near the threshold of pest or disease control, with a uniform distribution over the canopy to minimize losses to the soil or drift. In fact, it is generally accepted that the foliar application of a pesticide is an inefficient process, with only a fraction of the pesticide actually being retained on plants, and part of it being lost to the ground, (Balan, et al. 2008 and Nuyttens et al. 2009).

Low pressures of 15 to 40 PSI may be sufficient for spraying most herbicides or fertilizer, but high pressures up to 400 PSI or more may be needed for spraying insecticides. Spray nozzles are designed to be operated within a certain pressure range (Hofman, 2018).

The feedback control is applied to pipeline constant pressure spraying technique in order to solve the problems of unstable pressure and pipeline blowout, (Song et al., 2013). Nishiwaki et al. (2004) reported that spray height is the most significant variable in the prediction equation for spray drift. Nuyttens et al. 2007 reported that a statistical significant difference was noted in the reduction of spray drift for 54% when the boom height is decreased from 70 to 50 cm. While lowering the spray nozzle height from 50cm to 30cm significantly decreased the amount of spray drift 40.1%. Also Miller (2008) added that increasing of the nozzle height from 50 to 70 cm increased the airborne spray volume measured at 2.0 m downwind by a factor of approximately four. In general, nozzle height must be at optimum level according to nozzle characteristics for decreasing spray drift risk (Arvidsson, 1997 and Miller, 1999). Bruno et al. (2017) reported that agricultural production has become a key factor for stability of the world economy. The use of pesticides provides a more favorable environment for the crops in agricultural production. However, the uncontrolled and inappropriate use of pesticides affects the environment by polluting preserved areas and damaging ecosystems. The Parlatoria blanchardi is prevalent throughout the year but tends to increase markedly during spring and autumn. It develops three or four overlapping epidemiological generations per year. Oviposition over an extended period, overlapping of generations, and the presence of young nymphs throughout the year, are some of the obstacles to effective control. Latifian and Rad (2017) stated that the Parlatoria blanchardi is considered one of the most destructive pests of date palm trees. Al Antary et al. (2015) reported that This pest species injures date palm tree leaflets, leaves and fruits by sucking out plant sap with its mouth parts, subsequently causing deformations, defoliation and death of fronds due to the fact that Parlatoria blanchardi insect for date palm scales have toxic saliva, resulting in yield reduction.

Youssef (2002) reported that insect had three distinct peaks october, the second in march and third one in june. Adults and nymphs of this insect feed on leaves sap, remarkable damage occurs, resulting in early leaves drop and yield reduction (El-Said 2000). This subsequent damage leads to it reduces the production 30 - 50 kg per palm (Idder et al., 2006). Sometimes it reaches to 85 - 90 % losses depending on varietal tolerance, severity of infestation and orchard management (Ahmed 2004).

The chemical method is as efficient as physical method with a mortality percentage of 73.1-80% (Idder et al., 2007).

The objective of this paper is to study factors affecting the thermal fogger equipment for controlling of “Parlatoria Blanchardi Targ.” on date-palm trees.

MATERIALS AND METHODS

1. Materials:
   The thermal fogger

The tested thermal fogger contains of carburetor, cooling jacket, resonator length of 740 mm with diameter of 33 mm, shut off valve, chemical tank of 8 liters and fuel tank of 4.5 liters with an automatic start. The fogger has mass of 8.5 kg. The outlet tube of the tested fogger was modified by a tube addition having length of 1000 mm and diameter of 30.8 mm. So, the total resonator length increased to 1740 mm to suit with palm-tree heights. (Figs. 1 and 2). Fig. 2 shows thermal fogging views while Fig. 3 shows a section of carburetor with combustion chamber.

![Diagram of the tested thermal fogger](image_url)
Fig. 2. Views of the tested thermal fogger.

1-air intake 2-carburetor with diaphragm air 3-fuel adjustable screw 4-spark plug 5-combustion chamber 6-fuel intake.

Fig. 3. Section views of the carburetor with combustion chamber.

Fig. 4. Theory of thermal fogging.

1-adjustable direct fuel injection 2-carburetor with diaphragm air intake valve 3-double cooling jacket 4-cooling air intake and 5-water-injection for pre-cooling.

Tricycle Pullman

It made in china, model Pullman QS-E1.6, overall dimensions of 2900 x 1000 x 1200 mm, maximum speed of 40 km/h, mass of 500 kg, motor DC with 48 V / 800 W, 12 V battery, charging voltage of 220 V / 50 Hz and charging time of 6 - 8 h. (Fig. 5). The chemical tank of the thermal fogger with a capacity of 5 liters was filled with the mixture of combusts material of insects and diesel fuel.

Fig. 5. Views of the tricycle with the tested fogger.

Methods

The field experiments were carried out during seasons of 2017-2018 and 2018-2019 in a private farm in EL. Kasassin Ismailia Governorate to use thermal fogging for controlling "Parlatoria Blanchardi" (Targioni-Tozzetti) in date palm trees. The date-palm tree variety of Zoghloul was tested. The field experiments were conducted in an area of about 5 feddans of date palm, each row has 36 palm trees, row spacing with of 7-8 m and the average palm-tree height is 8 m.

A thermal-fogging was used the rate of 5 liter treated to ensure complete coverage of all parts of the date palm-trees. Twenty leaves from each treatment were randomly collected every four days over a period of three weeks. The collected samples were examined immediately to determine the average number of the alive individual nymphs and adults. The Kerosene is used as a control material of insects and diesel only for fogging.

The tested parameters were:

(1) Fogger type: (a) Mobiled fogger by human (b) Fogger attached to tricycle.

(2) Control material:

(a) Malathion 57 % EC (Emulsifiable concentrate) at rate of 1.5 L/100 L (0.3 %),
(b) Mineral oil “KZ” (Production of Kafir El-Zayat): 80 % at rate of 8 L/100 L (0.8 %),
(c) The mixture of mineral oils “KZ” and malathion 57 % EC with ratio of “1:1”,
(d) Without insecticide: It used diesel only for fogging.

(3) Tricycle forward-speeds: There were 0.6, 0.8, 1.0 and 1.2 m/s.
(4) Fog angle: The outlet-tube angles of 30°, 45° and 60° approximately were tested.

(5) Resonator length: Resonator lengths of 74 and 174 cm were tested.

Measurements:
Controlling efficiency: Mortality percentages were assessed every four days for three weeks and corrected by using Abbott’s formula (1925):

\[ \text{Controlling efficiency (Mortality)} \% = \left( \frac{M_1 - M_2}{100 - M_2} \right) \times 100 \]

Where: \(M_1=\) Mortality in treatment, \(M_2=\) Mortality in control, \%

Fogger capacity: It was calculated using Amin (1994) equation:

\[ \text{Fogger productivity, tree/h} = \frac{3600 \times \text{No. of trees}}{\text{Time, s}} \]

Hourly, operation and production costs of using the tested thermal fogger: The hourly cost of thermal fogger was calculated according to the equation given by Awaysy (1998), as indicated by the following:

\[ C = \frac{P}{H} \left[ \frac{1}{Y} + \frac{i}{2} + t + m \right] + \left( A, K, K_1 \right) \]

Where: \(C=\) Total hourly cost, \(P=\) initial price or capital of device, \(H=\) estimated yearly operating hours, \(Y=\) estimated life expectancy of device in years, \(i=\) interest or investment rate, \(T=\) taxes and overhead rates, \(M=\) maintenance and repairs ratio to capital head, \(A=\) ratio of rated power and lubrication related to fuel cost (0.75 - 0.9) depending on engine performance, \(K=\) power in kW, \(u=\) price of fuel per L, \(s=\) monthly salaries, and 144 = estimated working hours per month.

The operation and production costs were calculated according the following equations:

- **Operation cost, L/E/Tree** = Hourly cost, L/E/h / Fogger capacity, tree/h

- **Production cost, L/E/tree** = Fogger machine cost, L/E/h / Fogger capacity, tree/h

### RESULTS AND DISCUSSION

1. Control efficiency mobile fogger by human.

Table 1 shows the effect of control material, fog angle and resonator length on control efficiency of mobile fogger by human on the nymphs and adult insect.

Table 1. Effect of control materials, fog angle and resonator lengths on control efficiency using mobile fogger by human for the nymphs and adult insect.

<table>
<thead>
<tr>
<th>Resonator length, cm.</th>
<th>Insect stage</th>
<th>Control material</th>
<th>Control efficiency, %.</th>
<th>Fog angle, degree.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nymphs</td>
<td>Malathion + KZ</td>
<td>74.7</td>
<td>69.8</td>
</tr>
<tr>
<td></td>
<td>Malathion</td>
<td>65.7</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>Without insecticide</td>
<td>61.9</td>
<td>59.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adult</td>
<td>Malathion + KZ</td>
<td>76.19</td>
<td>71.2</td>
</tr>
<tr>
<td></td>
<td>Insect</td>
<td>Malathion</td>
<td>67.01</td>
<td>63.24</td>
</tr>
<tr>
<td></td>
<td>Without insecticide</td>
<td>63.14</td>
<td>60.69</td>
<td></td>
</tr>
<tr>
<td>174</td>
<td>KZ</td>
<td>76.19</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nymphs</td>
<td>Malathion + KZ</td>
<td>81.85</td>
<td>78.1</td>
</tr>
<tr>
<td></td>
<td>Malathion</td>
<td>74.2</td>
<td>72.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Without insecticide</td>
<td>70.6</td>
<td>69.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>KZ</td>
<td>9.3</td>
<td>10.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adult</td>
<td>Malathion + KZ</td>
<td>83.56</td>
<td>81.47</td>
</tr>
<tr>
<td></td>
<td>Insect</td>
<td>Malathion</td>
<td>76.43</td>
<td>72.31</td>
</tr>
<tr>
<td></td>
<td>Without insecticide</td>
<td>72.72</td>
<td>70.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>KZ</td>
<td>16.95</td>
<td>15.08</td>
<td></td>
</tr>
</tbody>
</table>

The maximum control efficiencies recorded 83 and 85.4 % were obtained at fog angle 45°, resonator length of 174 cm and control material of “KZ” for nymphs and adult insect respectively. Meanwhile, the minimum control efficiencies noted 59.5 and 60.6% were obtained at fog angle of 60°, resonator length of 74 cm and control materials of “Malathion” for nymphs and adult insect respectively.

Without insecticide (control), the maximum control efficiencies of 10.2 and 19.45 % were obtained at fog angle of 45° and resonator length 174 cm for nymphs and adult insect respectively. Meanwhile, the minimum controlling efficiency of 8.3 and 14.6 % were obtained at fog angle of 60° and resonator length 74 cm for nymphs and adult insect respectively.

Increasing of control efficiency by using fog angle 45° compared with fog angles of 30° and 60° is due to the best penetration of insecticide through date-palm tree leaves. Meanwhile, increasing of control efficiency by increasing resonator length from 74 to 174 cm is due to increase of contact, diffusion and decreasing of loss and evaporation of insecticide.

2. Control efficiency for fogger attached to tricycle.

Figs. 6 and 7 show the effect of tricycle forward-speed, control material, fog angle and resonator length on control efficiency for the nymphs and adult insect.

The maximum control efficiencies for the nymphs and adult insect were 84.7 and 95.81 % respectively, under fog angle of 45°, resonator length of 174 cm, control material of “KZ” and forward-speed of 0.6 m/s. Meanwhile, the minimum control efficiencies for the nymphs and adult insect were 59.9 and 65.31 % respectively, using fog angle of 60°, resonator length of 74, control materials of “Malathion” and forward-speed of 1.2 m/s.

Without insecticide (control), the maximum control efficiencies for the nymphs and adult insect were found 54.90 and 58.19 % respectively under fog angle 45°, resonator length 174 cm and forward-speed of 0.6 m/s. Meanwhile, the minimum control efficiencies for the nymphs and adult insect were 37.39, and 43.0 % respectively, under fog angle of 60°, resonator length 74 cm and forward-speed of 1.2 m/s.

For the nymphs, the averages of control efficiency were 72.99, 66.43, 63.79 and 41.86 % for control material of “KZ”, “Malathion + KZ”, “Malathion” and without insecticide respectively at all tested tricycle forward-speeds and fog angles under resonator length of 74 cm. Meanwhile, the averages of control efficiency were 81.29, 73.13, 71.91 and 48.11 % for control material of “KZ”, “Malathion + KZ”, “Malathion” and without insecticide respectively at all tested tricycle forward-speeds and fog angles using resonator length of 174 cm.

For the adult insect, the averages of control efficiency were 85.05, 75.11, 71.86, and 49.24 % using control material of “KZ”, “Malathion + KZ”, “Malathion” and without insecticide respectively at all tested tricycle forward-speeds and fog angles using resonator length of 74 cm. Meanwhile, the averages of control efficiency were 94.03, 84.43, 82.56 and 52.19 % using control material of “KZ”, “Malathion + KZ”, “Malathion” and without insecticide respectively at all tested tricycle forward-speeds and fog angles using resonator length of 174 cm.

The averages of control efficiency were 79.92, 77.82, 75.86, and 73.93 % using tricycle forward-speeds of 0.6, 0.8, 1.0 and 1.2 m/s respectively, for all tested control materials, resonator lengths, fog angles and insect-stages.
Increasing of control efficiency by decreasing the time of insecticide penetration inside the palm leaves, consequently the insect is exposed to fog and the active substance is greater.

3. Fogger capacity of mobile fogger by human.

Table 2 shows the effect of control material, fog angle and resonator length on fogger capacity using mobiled fogger by human.

The maximum fogger capacity for resonator lengths of 74 and 174 cm were 78.3 and 89 tree/h respectively under fog angle of 45° and “KZ” control material. Meanwhile, the minimum fogger capacity for resonator lengths of 74 and 174 cm were 59.8 and 63.4 tree/h respectively under fog angle of 60° and “Malathion” control material.

The maximum fogger capacity for resonator lengths of 74 and 174 cm were 45 and 52 tree/h respectively under fog angle of 45° and without insecticide (control). Meanwhile, the minimum fogger capacity for using resonator lengths of 74 and 174 cm were 38 and 42 tree/h respectively using fog angle of 60°, without using insecticide (control). The maximum fogger capacity of 89 tree/h was found under resonator length of 174 cm. It may be due to the fogger covered all tree heights.

Increases the fogger capacity at the fog angle of 45° is due to the increasing penetration uniformity of insecticide through palm tree leaves per less time is compared to both application angles.

Table 2. Effect of control material, fog angle and resonator length on fogger capacity using mobiled fogger by human.

<table>
<thead>
<tr>
<th>Resonator length, cm</th>
<th>Control materials</th>
<th>Fogger capacity, tree/h</th>
<th>Fog angle, degree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type</td>
<td>30°</td>
<td>45°</td>
</tr>
<tr>
<td>74</td>
<td>KZ</td>
<td>74.1</td>
<td>78.3</td>
</tr>
<tr>
<td></td>
<td>Malathion + KZ</td>
<td>70.7</td>
<td>75.2</td>
</tr>
<tr>
<td></td>
<td>Malathion</td>
<td>66.7</td>
<td>73.5</td>
</tr>
<tr>
<td></td>
<td>Without insecticide</td>
<td>41.5</td>
<td>45</td>
</tr>
<tr>
<td>174</td>
<td>KZ</td>
<td>86.2</td>
<td>89.1</td>
</tr>
<tr>
<td></td>
<td>Malathion + KZ</td>
<td>77.8</td>
<td>81.2</td>
</tr>
<tr>
<td></td>
<td>Malathion</td>
<td>68.1</td>
<td>71.9</td>
</tr>
<tr>
<td></td>
<td>Without insecticide</td>
<td>48.5</td>
<td>52</td>
</tr>
</tbody>
</table>

4. Fogger capacity for fogger attached to tricycle.

Fig. 8 shows the effect of tricycle forward-speed on fogger capacity for fogger attached to tricycle.

Results show the fogger capacities were 93, 108, 120 and 132 tree/h using tricycle forward-speeds of 0.6, 0.8, 1.0 and 1.2 m/s respectively, with using all fog angles, control materials and resonator lengths.

Increasing fogger capacity by increasing forward-speed is due to decreasing the control time.
5. Date palm fruit yield at optimum for fog angle of 45° and resonator length of 174 cm.

Fig. 9 shows the effect of tricycle forward-speed and insecticide material on “Zaghloul” date palm fruit yield at optimum fog angle of 45° and resonator length of 174 cm.

At optimum fog angle of 45° and resonator length of 174 cm, the maximum “Zaghloul” fruit yield of 109.6 kg/tree under forward-speed of 0.6 m/s and control material type of “KZ”. Meanwhile, the minimum “Zaghloul” fruit yield of 88.2 kg/tree was obtained under forward-speed of 1.2 m/s and control material type of “Malathion”.

Using optimum fog angle of 45°, resonator length of 174 cm and without insecticide (control), the maximum and minimum of “Zaghloul” fruit yields were 77.51 and 68.5 kg/tree at forward-speed of 0.6 and 1.2 m/s respectively.

The optimum conditions using the fogger attached to tricycle recorded at forward-speed of 1.2 m/s, fog angle of 45°, control materials type of “KZ” and resonator length of 174 cm. The results obtained with optimum conditions were: control efficiency of 84.7 and 95.81 %, fogger capacity 132 tree/h, date fruit yield of 101.5 kg/tree, hourly, operation and production costs of 26.2 L.E./h, 0.20 L.E./ tree and 1.96 L.E./Mg fruit respectively.

### CONCLUSION

The optimum conditions using the fogger attached to a tricycle were forward-speed of 1.2 m/s, fog angle of 45°, control materials type of “KZ” and resonator length of 174 cm. The results obtained with optimum conditions were: control efficiency of 84.7 and 95.81 %, fogger capacity 132 tree/h, date fruit yield of 101.5 kg/tree, hourly, operation and production costs of 26.2 L.E./h, 0.20 L.E./ tree and 1.96 L.E./Mg fruit respectively.

### REFERENCES


عوامل مؤثرة على آلة الصياح الحارى لمكافحة الحشرة القشرية البيضاء على أشجار نخيل البلح

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تختبر الحشرة القشرية البيضاء من الآفات المدارية التي تؤثر في محصول الليمون، إذ تعتبر هذه الآفة نشأت نتائج في مصادر مكافحة حشرات وقائية صناعية له، حيث تستخدم المحلية الصناعات المدارية باستخدام آلات الضباب الحراري. فكل من حشرات وتهوية الحشرة قطر الصابع يتأثر بآلة الضباب الحراري، وتتهوى أكثر من قطر الصابع في الريح.كفاح الآفة أو تأثيرها على الآفات يعتمد على استخدام الزيوت المعدنية أو الخليط الزيوت.صمم المراقب العامل relevant


