J. of Soil Sciences and Agricultural Engineering, Mansoura Univ., Vol. 12 (3):81-87, 2021

Journal of Soil Sciences and Agricultural Engineering

Journal homepage: www.jssae.mans.edu.eg
Available online at: www.jssae.journals.ekb.eg

Factors Affecting the Thermal Fogger for Controlling of "Parlatoria Blanchardi Targ." on Date-Palm Trees

Mervat M. Atallah[1*]; M. I. M. Ahmad[1]; A. A. Eliwa[1] and A. A. Selim[2]

[1] Ag. Eng. Res. Institute, Ag. Res. Center, Dokki, Giza, Egypt.
[2] Plant Protection Institute, Ag. Res. Center, Dokki, Giza, Egypt.

Cross Mark

ABSTRACT

The aim of this research is to study factors affecting thermal fogger for controlling "Parloria 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 (30º, 45º and 60º) 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 45º, 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 tree/h using tricycle forward-speeds of 0.6, 0.8, 1.0 and 1.2 m/s respectively. Using optimum fog angle of 45º 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 45º approximately and resonator length of 174, 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 "Parloria 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 comes in contact with an insect is higher compared to other machines. It needs to be underlined it is necessary that the sprayed particle contacts with the bug or the virus to ensure that they die out. Britch *et al.* (2010) studied that the impact of Ultra-low-volume (ULV) "cold mist" spraying, and thermal fog applications of malathion against caged sentinel mosquitoes in the field in a warm temperate area of Florida, followed by a similar test in a hot-dry desert area of southern California. Patterns of mortality throughout 150 m X 150 m grids of sentinel mosquitoes indicate greater efficacy from the thermal fog application in both environments under suboptimal ambient weather conditions.

And stated that droplets from thermal fogger number in the 1,000 s. Droplet density from the thermal fogger application is significantly higher than the droplet density from the ULV application. Thermal fog application of malathion was demonstrated to be moderately more efficacious, compared to the ULV application, in killing, penetrating at least (105 m) into a date palm. The thermal fog aerosol resulted in kill further and wider through an area with tall vegetation despite high wind energy and sudden changes in wind direction. Thermal fogging is used for any pest control task where active substances should be uniformly distributed, even in inaccessible places, without leaving undesirable residues. This fogging method is the solution for treating large areas and spaces with a minimum quantity of pesticide solution, less operational work and with little harm to the environment.

Date palm (*Phoenix dactylifera* L.) is the most ancient tree cultivated since 4000 B.C. (El-Shibli and Korelainen, 2009). *Parlatoria blanchardi* Targ. is considered one of the most dangerous pests that infest the Arecaceae family, including date palm in all its cultivation regions. It is one of the most feared pests and especially in the newly planted regions (Gassou, 2015). Droplet size is one of the most significant factors affecting the success of vector control applications, it is critical to know baseline droplet and spray cloud characteristics for the equipment used. Fogging machines generally fall into 1 of 2 types: thermal foggers and cold foggers. Thermal foggers are generally smaller, lighter, more portable, and less expensive than truck-mounted ultra-low volume (ULV) sprayers. Median droplet sizes of thermal foggers are generally 15 µm or less, the exact size dependent on several factors, including the particular nature of solvent used in mixture (Mabbett 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

[*] **Corresponding author.**
E-mail address:mervatatallah2018@gmail.com
DOI: 10.21608/jssae.2021.153543

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 blanchardii 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 blanchardii 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 (Idris *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).

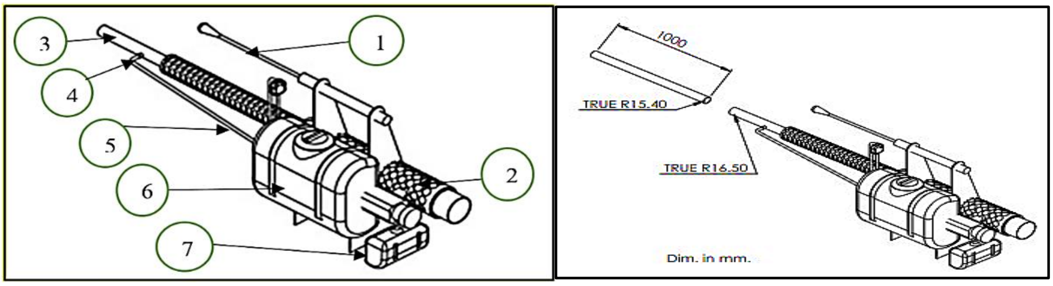
The objective of this paper is to study factors affecting the thermal fogger equipment for controlling of “Parlatoria Blanchardi Targ.” on date-palm trees.

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 modificated 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.



Resonator length of 740 mm **Resonator length of 1740 mm**

1- hand pump 2- cooling jacket for combustion chamber 3- resonator, 4- shut-off valve 5- chemical flow tube 6- chemical tank 7- fuel tank.

Fig. 1. Isometric of the tested thermal fogger.

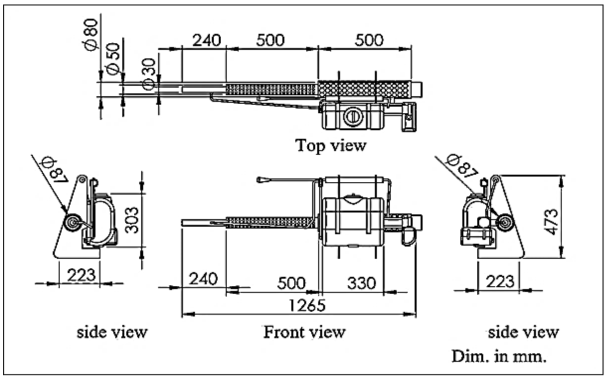
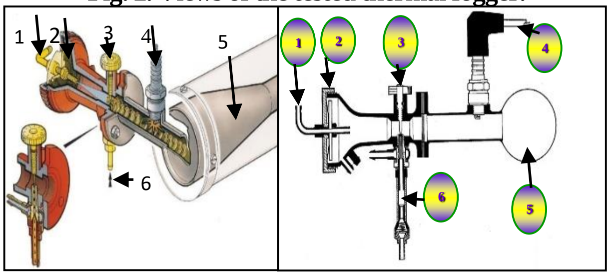


Fig. 2. Views of the tested thermal fogger.

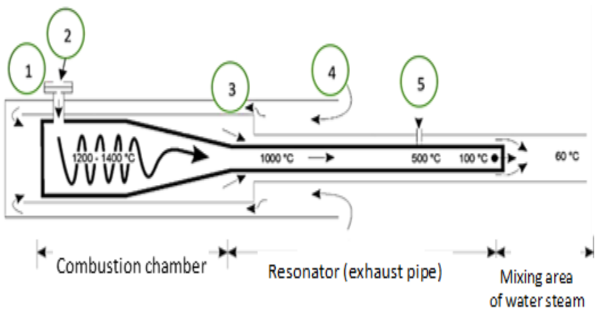


1-air intake 2- carburetor with diaphragm air 3- fuel adjustable screw 4- spark plug 5- combustion chamber 6- fuel intake.

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

Fogging theory

Thermal fogging is the generation of ultra-fine droplets in a range of 1-50 µm using thermal pneumatic energy Fig. 4). Liquid substances are vaporized at the end of fogging barrel (resonator) and form ultra-fine aerosols by condensing on contact with cool ambient air, on being ejected, to create dense visible fog-clouds. The water is injected into the resonator at a point of higher temperature and cools down the hot exhaust gases into the exhaust pipe to the water steam temperature of an open system of 100 °C. The pesticide with a sensitive active ingredient is injected at a cooler point, where it is subject to a temperature of 100 °C for 0.05 - 0.1 second. This leads to an even lower temperature of between 40 – 60 °C into the mixing area. The period during which the chemical solution remains in the hot exhaust is only 0.05 to 0.1 seconds. The fog is then rapidly expelled into the air where the temperature is greatly reduced. Chemical solutions applied by the fog do not remain heated for a long enough time for heat to affect the solution. When a drop of water falls on a hot surface it dances for a long time before evaporating quickly. This is a result of the creation of a fine vapor layer that surrounds the droplet upon encountering such heat. This vapor layer acts to insulate the droplet from further evaporation.



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

Fig. 4. Theory of thermal fogging.

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 combats material of insects and diesel fuel.

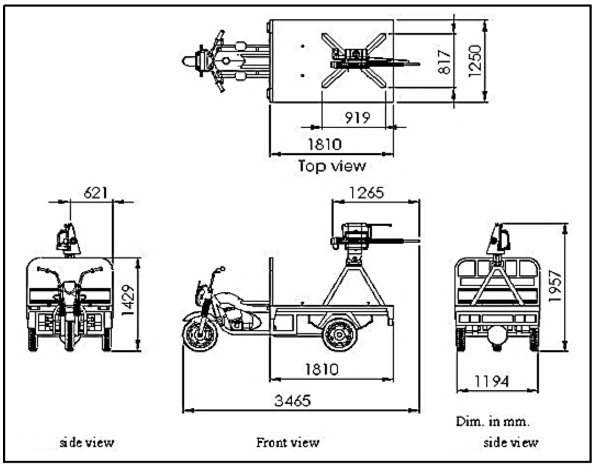


Fig. 5. Views of the tricycle with the tested fogger.

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 to 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 carrier compounds and helps transformation the control materials into a fog. The concentration each of Malathion is 0.3 %, mineral oil 0.8 %, and the mixture Malathion to mineral oil with ratio of 1 : 1.

The fogger device was installed on a stand and tested with angles of 30º, 45º and 60º. The outlet tube of the tested fogger was extended by a tube addition with length of 100 cm and diameter of 30.8 mm. So, the total resonator length increased to 174 cm to suit with palm-tree heights.

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 Kafr 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 30º, 45º and 60º 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):

$$\text{Controlling efficiency (Mortality) \%} = \{(M_1 - M_2) / (100 - M_2)\} \times 100$$

Where: M_1 = Mortality in treatment, % and 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 Awady (1998), as indicated by the following:

$$C = P/H \{1/Y + i/2 + t + m\} + \{A.K.\ f.u\} + S/144$$

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 = investment or interest 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, f = specific fuel-consumption in L/kW.h, 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, LE/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.

Resonator length, cm.	Insect stage.	Control material.	Control efficiency, %. Fog angle, degree.		
			30^0	45^0	60^0
74	Nymphs.	KZ	74.7	78	69.8
		Malathion + KZ	65.7	69.4	62
		Malathion	61.9	64.8	59.5
		Without insecticide	9.1	9.6	8.3
	Adult Insect.	KZ	76.19	79.56	71.2
		Malathion + KZ	67.01	70.79	63.24
		Malathion	63.14	66.1	60.69
		Without insecticide	16.5	18.7	14.6
174	Nymphs.	KZ	80.5	83	78.1
		Malathion + KZ	74.2	76.4	72.2
		Malathion	70.6	73.5	69.1
		Without insecticide	9.3	10.2	9.4
	Adult Insect.	KZ	83.56	85.4	81.47
		Malathion + KZ	76.43	78.69	72.31
		Malathion	72.72	75.71	70.2
		Without insecticide	16.95	19.45	15.08

The maximum control efficiencies recorded 83 and 85.4 % were obtained at fog angle 45º, 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 60.69 % were obtained at fog angle of 60º, 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 45º 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 60º and resonator length 74 cm for nymphs and adult insect respectively.

Increasing of control efficiency by using fog angle 45º compared with fog angles of 30º and 60º 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 45º, 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 60º, 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 45º, 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 60º, 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.

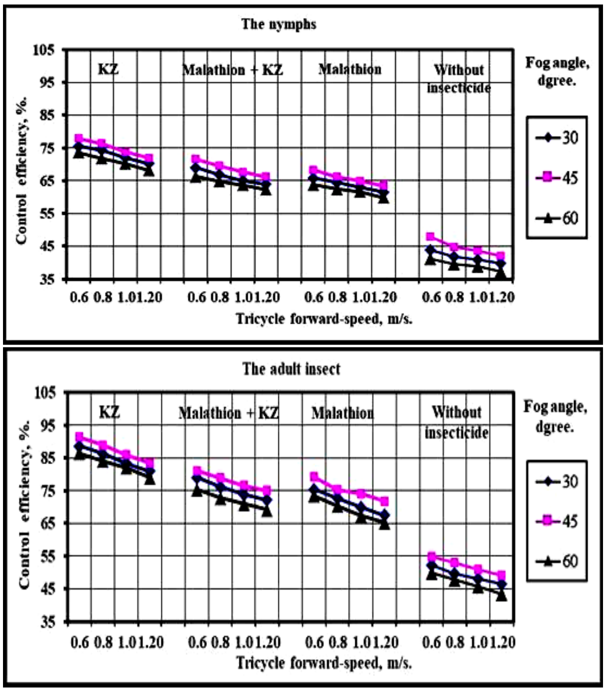


Fig. 6. Effect of tricycle forward-speed, control material, fog angle on control efficiency under resonator length of 74 cm for the nymphs and the adult insect.

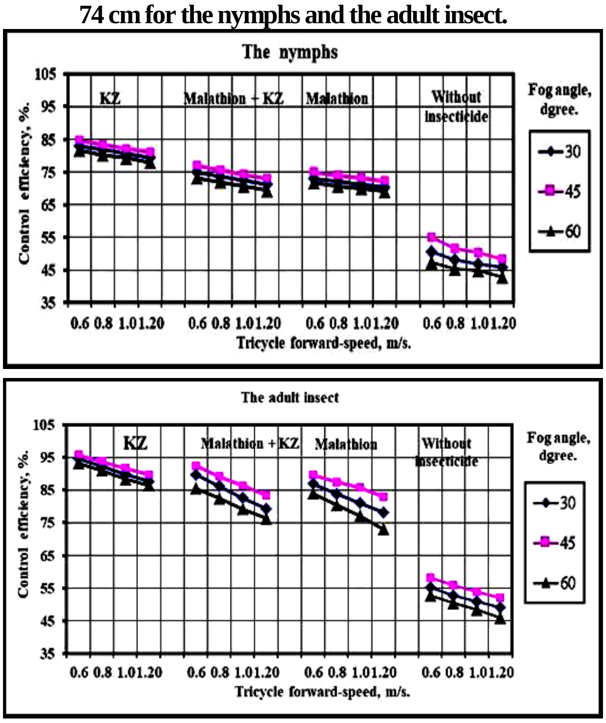


Fig. 7. Effect of tricycle forward-speed, control material, fog angle on control efficiency under resonator length of 174 cm for the nymphs and the adult insect.

The averages of control efficiency were 76.80, 79.26, and 74.58 % using fog angles of 30⁰, 45⁰ and 60⁰ respectively using all tested control materials, resonator lengths and insect-stages.

The averages of control efficiency were 72.54 and 81.22 % using resonator lengths of 74 and 174 cm respectively for all tested control materials, fog angles and insect-stages. The resonator length of 174 cm is using to reach the tree height more easily.

Increasing of control efficiency by decreasing sprayer fog forward-speed is due to increasing the time of insecticide spraying fog and accordingly increasing of 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 45⁰ 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 60⁰ 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 45⁰ 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 60⁰, 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 45⁰ 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.

Resonator length, cm.	Control materials Type.	Fogger capacity, tree/h. Fog angle, degree. 30⁰	45⁰	60⁰
74	KZ	74.1	78.3	73.7
	Malathion + KZ	70.7	75.2	70.4
	Malathion	66.7	73.5	59.8
	Without insecticide	41.5	45	38
174	KZ	86.2	89.1	79.3
	Malathion + KZ	77.8	81.2	71.5
	Malathion	68.1	71.9	63.4
	Without insecticide	48.5	52	42

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.

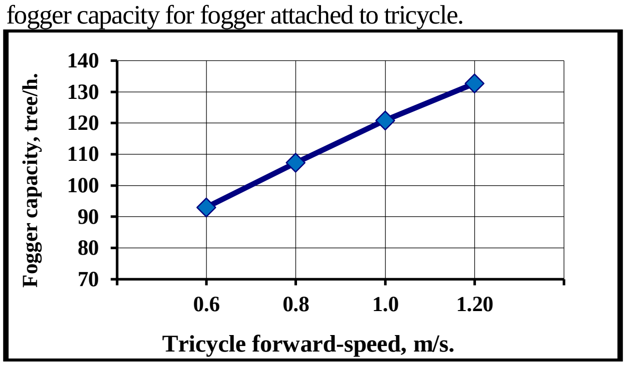


Fig. 8. Effect of tricycle forward-speed on fogger capacity.

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 45º 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 45^0 and resonator length of 174 cm.

At optimum fog angle of 45º 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 45º, 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.

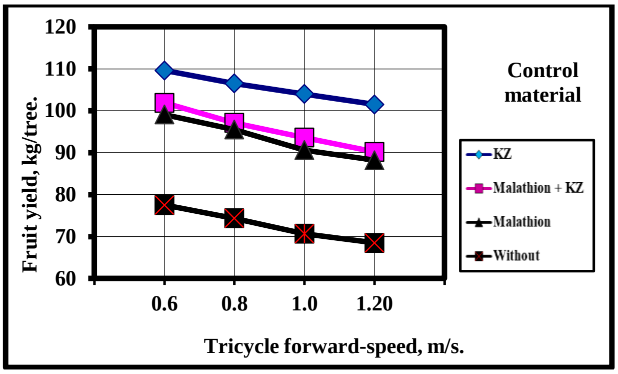


Fig. 9. Effect of tricycle forward-speed and insecticide-materials on "Zaghloul" date palm fruit yield at optimum fog angle of 45º and resonator length of 174 cm.

6. Costs of using the fogger attached to the tricycle.

Table 3 shows the costs of using the fogger attached to tricycle.

Table 3. Operation and production costs using the fogger with deferent tricycle forward-speed, control material with resonator length 174 cm and fog angle of 45º.

Control materials type	Forward speed, m/s.	Hourly cost, L.E./h.	Fogger capacity, tree/h.	Operation cost, L.E./tree.	Fruit yield, kg/tree.	Production cost, L.E./Mg.
	0.6	24.6	93	0.26	109.6	2.41
KZ	0.8	25.1	108	0.23	106.5	2.18
	1.0	25.7	120	0.21	104.0	2.06
	1.2	26.2	132	0.20	101.5	1.96
	0.6	24.6	93	0.26	101.9	2.60
Malathion	0.8	25.1	108	0.23	97.1	2.39
+ KZ	1.0	25.7	120	0.21	93.6	2.29
	1.2	26.2	132	0.20	90.2	2.20
	0.6	24.6	93	0.26	99.1	2.67
Malathion	0.8	25.1	108	0.23	95.5	2.43
	1.0	25.7	120	0.21	90.6	2.36
	1.2	26.2	132	0.20	88.2	2.25
Without	0.6	24.6	93	0.26	77.5	3.41
Insecticide	0.8	25.1	108	0.23	74.4	3.13
(Control)	1.0	25.7	120	0.21	70.6	3.03
	1.2	26.2	132	0.20	68.0	2.92

The hourly, operation and production costs for the fogger attached to tricycle of 24.6 - 26.2 L.E./h, 0.20 – 0.26 L.E./tree and 1.96 - 2.41 L.E./Mg fruit, respectively using "KZ" insecticide material. Meanwhile, the maximum range of production cost of using the fogger attached to tricycle at forward speed range of 0.6 - 1.2 m/s was 3.41 – 2.92 L.E./Mg fruit without using insecticide material.

The optimum conditions the fogger attached to a tricycle were forward-speed of 1.2 m/s, fog angle of 45º, 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 recorded at forward-speed of 1.2 m/s, fog angle of 45º, 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 capacity132 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

Abbott, W.S. (1925) A method of computing the effectiveness of an insecticide. J. Econ. Entomol. 18: 265-267.

Ahmed, M.A. (2004) The efficacy of Confidor 200 SL against the green date palm pit scale insect (Asterolicanium phoenicis Rao) (Homoptera: Asterolicaniidae). Proceedings of 2nd national pest management conference. Faculty of Agric Sci Univ. of Gezira, Sudan, 2004.

Al Antary, T. M., M. M. Al-Khawaldeh and M. A. Ateyyat (2015) Economic importance of date palm Phoenix dactylifera L. (Liliopsida: Arecales: Arecaceae) pests in Jordan Valley. Braz. J. Biol. Sci., 2: 101-109.

Amin, E. E. A. A. (1994). Development of a grading machine for some horticulture farm crops. J.Agric. Sci. Mansoura Univ. 19(7) :3139-3149.

Arvidsson, T. (1997) Spray drift as influenced by meteorological and technical factors: a methodological study 1997: Swedish University of Agricultural Sciences.

Awady, M. N. (1998) Engineering of tractors and Agricultural machinery. TextBook., col. Ag., Ain-shams Univ., 5 th. Ed.,: 164-167. (In Arabic).

Balan, M. G.; O. J. G. Abi-Saab, C. G. da Silva and A. do Rio (2008) Deposition of the spraying suspension for three spray nozzles under different meteorological conditions. Semin. Cienc. Agrar. 2008, 29, 293–298.

Bode, L., B. Butler, and C. Goering (1976) Spray drift and recovery as affected by spray thickener, nozzle type, and nozzle pressure [in applying agricultural pesticides]. Transactions of the ASAE, 1976. 19.

Britch S. C.; K. J. Linthicum; C. W. W. Wynn; T. W. Walker; M. Farooq; V. L. Smith; E. C. A. Robinson; B. B. Lothrop; M. Snelling; A. Gutierrez and H. D. Lothrop (2010) Evaluation of ULV and thermal fog mosquito control applications in temperate and desert environments. Journal of the American Mosquito Control Association, 26(2):183-197.

Bruno S.F., H. Freitas, P. H.Gomes, L. Y.Mano, G. Pessin, A. C.P.L.F.de Carvalho, B. Krishnamachari and J. Ueyama (2017) An adaptive approach for UAV-based pesticide spraying in dynamic. Computers and Electronics in Agriculture 138 : 210–223.

Cerruto E. , G. Emma and G. E. Manetto (2009) Spray applications to tomato plants in greenhouses. II. Effect of spray lance type. Journal of Ag. Eng. - Riv. di Ing. Agr., September 2009,40(3):49-56

El-Said, M. I. (2000) Survey of date palm insects in North Sinai with special reference to the ecology and biology of the species, Parlatoria blanchardii (Targ.-Tozz), supper family Coccoidea. M.Sc. Thesis, Fac. of Agric., Cairo Univ., 97 pp.

El-Shibli, S. and H. Korelainen (2009) Biodiversity of date palm Phoenix dactylifera L. in Sudan: Chemical, morphological and DNA polymorphism of selected cultivars. Plant Genet. Resour. (7), 194-203 pp.

Gassou, I. (2015) Essai de quelques extraits végétaux dans la lutte contre La cochenille blanche *Parlatoria blanchardi* Targ. Dans la région d'Ouargla. ouargla, Kasdi Merbah University, 85p.

Hofman V. (2018) Spray Equipment and Calibration. Agricultural and Biosystems Engineering North Dakota State University, Fargo, Reviewed March 2018

Idris T. I. M., A. H. Ibrahim, A. K. Taha (2006) A study of the current status of date palms in the Nothern State. Technical report, Agric. Res. Corp. and the Univ. of Dongola, Sudan, 2006, 85.

Idder, A. M., M. Bensaci, M. Oualan, and B. Pintureau (2007) Efficacité comparée de trois méthodes de lutte contre la Cochenille blanche du Palmier dattier dans la région d'Ouargla (Sud–est algérien) (Homoptera, Diaspididea). Bulletin de la Société Entomologique , 112, 191-196.

Latifian, M. and B. Rad (2017) Efficacy of cultural control for date palm borer management. Indian J. Plant Prot., 45: 7-11.

Mabbett T. (2003) Fogging for public health protection. Int Pest Control 45:308-310338. Matthews GA. 1996. Application of insecticides in dengue control. Pest Out 7:24-30.

Mabbett T. (2004) Fogged protection for food on the move. Int Pest Control 46:323-324.

Mabbett T. (2006) Blanket protection from carrier pests. Pest Control 74:45-49.

Miller P. (1999) Factors influencing the risk of drift into field boundaries. In brighton crop protection conference weeds. 1999.

Miller P. (2008) Factors influencing the risk of spray drift from nozzles operating on a boom sprayer. in International Advances in Pesticide Application, Robinson College, Cambridge, UK, 9-11 January 2008. 2008a. Association of Applied Biologists.

Nishiwaki K., K. Amaha, R. Otani (2004) Development of nozzle positioning system for precision sprayer, Automation technology for off-road equipment, ASAE, St. Joseph, Michigan, USA, 2004.

Nuyttens, D., M. DE Schampheleire, , K. Betens, and B. Sonck (2007) The influence of operator- controlled variables on spray drift from field crop sprayers. Transactions of the ASABE, 2007b. 50(4): p. 1129-1140.

Nuyttens, D.; P. Braekman; S. Windey; B. Sonck (2009) Potential dermal pesticide exposure affected by greenhouse spray application technique. Pest Manag. Sci. 2009, 65, 781–790.

Rincón, V. J.; M. Grella; P. Marucco; L. E. Alcatrão; J. Sanchez-Hermosilla; P. Balsari (2020) Spray performance assessment of a remote-controlled vehicle prototype for pesticide application in greenhouse tomato crops. Sci. Total Environ. 2020, 726, 113 8509 (1-14).

Sánchez-Hermosilla, J. ; V. J. Rincón; F. Páez,; F. Agüera and F. Carvajal, (2011) Field evaluation of a self-propelled sprayer and effects of the application rate on spray d eposition and losses to the ground in greenhouse tomato crops. Pest Manag. Sci. 2011, 67, 942–947.

Song Shuran, Hong Tiansheng, Sun Daozong (2013) SCM-based pipeline constant pressure spraying control device constant pressure patent [P]: Chinese Patent: ZL200910193010.0, 2013-05-01.

WHO [World Health Organization] (1990) Equipment for vector control. 3rd ed. Geneva, Switzerland: World Health Organization.

WHO [World Health Organization] (2003) Space spray application of insecticides for vector and public health pest control: a practitioner's guide WHO/CDS/ WHOPES/GCDPP/2003.5. Geneva, Switzerland: World Health Organization.

WHO [World Health Organization] (2006) Equipment for vector control: specification guidelines. Geneva, Switzerland: World Health Organization.

Youssef, A. E. (2002) Ecological studies on date palm scale insect, Parlatoria blanchardii (Targ.) on two date palm varieties at Kafr El- Sheikh Governorate. J. of Agri. Sci., Mansoura (27): 1291-1299 pp.

عوامل مؤثرة على آلة الضباب الحرارى لمكافحة الحشرة القشرية البيضاء على أشجار نخيل البلح

مرفت محمد عطالله[1]*، محمد ابراهيم محمد أحمد[1]، عاطف أحمد عليوه[1] و أحمد عبد الفتاح سليم[2]

[1] معهد بحوث الهندسة الزراعية، مركز البحوث الزراعية

[2] معهد بحوث وقاية النباتات، مركز البحوث الزراعية

تعتبر الحشرة القشرية البيضاء من الآفات الخطيرة التى تؤثر فى محصول التمور. يعتبر إختيار الوسيلة المناسبة للمكافحة أمر ضرورى للحد من أضرارها الإقتصادية. توسعت الإصابة بهذه الحشرة فأصابت ما يقرب من مليون نخلة. ومن المتوقع فى ظل التقصير فى المكافحة إصابة جميع أشجار نخيل البلح بالحشرة. يهدف هذا البحث إلى دراسة بعض العوامل المؤثرة على إستخدام آلة الضباب الحرارى لمكافحة إنتشار الحشرة القشرية البيضاء "Parloria Blanchardii" على أشجار نخيل البلح. تم تعديل طول وقطر أنبوبة تدفق الضباب فى آلة الضباب الحرارى إلى 1740 مم و30,8 مم على التوالى ليناسب إرتفاع شجرة النخيل وسهولة تدفق الضباب. تضمنت المتغيرات المدروسة: نوع آلة الضباب الحرارى: (أ) آلة الضباب محمولة بواسطة العامل (ب) آلة الضباب مركبة على دراجة ثلاثية العجلات ، نوع المبيد: (أ) الملاثيون 57٪ EC (مركز قابل للإستحلاب) بمعدل 1,5 لتر/ 100 لتر (0,3٪)، (ب) الزيوت المعدنية "KZ" (إنتاج شركة كفر الزيات): 80٪ بمعدل 8 لتر/ 100 لتر (0,8٪)، (ج) خليط الزيوت المعدنية "KZ" والملاثيون 57٪ EC بنسبة (1 : 1) ، سرعات أمامية 0,6 و0,8 و1,0 و1,2 م / ث، كانت زوايا الضباب 30 و45 و60 درجة وطول أنبوب التدفق: أنبوب التدفق بأطوال 74 و174 سم. تم تلخيص النتائج الرئيسية في النقاط التالية: كانت أقصى كفاءة مقاومة للحوريات والحشرات البالغة 84,7 و95,81 ٪ على التوالي، بإستخدام زاوية ضباب 45 درجة تقريبا ، وطول أنبوب التدفق 174 سم، ونوع المبيد من الزيوت المعدنية "KZ" وسرعة أمامية 0,6 م / ث. بينما كانت أقل كفاءة مقاومة للحوريات والحشرات البالغة 59,9 و65,31 ٪ على التوالي، بإستخدام زاوية ضباب 60 درجة، وطول أنبوب التدفق 74، ونوع المبيد "الملاثيون" والسرعة الأمامية 1,2 م / ث. كانت معدل أداء آلة الضباب 93 و107 و121 و133 شجرة / ساعة بإستخدام دراجة ثلاثية العجلات بسرعات أمامية 0,6 و0,8 و1,0 و1,2 م / ث على التوالي. بإستخدام زاوية الضباب المثلى 45 درجة تقريبا، وطول أنبوب التدفق 174 سم، كان الحد الأقصى لمحصول نخيل التمر صنف "زغلول" 109,6 كجم / شجرة بسرعة أمامية 0,6 متر/ ثانية ونوع المبيد "KZ". في حين تم الحصول على الحد الأدنى من محصول نخيل التمر صنف "زغلول" 88,2 كجم/شجرة بإستخدام سرعة أمامية 1,2 م/ ث ونوع المبيد "الملاثيون". بإستخدام زاوية ضباب مثالية تبلغ 45 درجة تقريبا وطول أنبوب التدفق 174، كان الحد الأدنى من تكاليف التشغيل والإنتاج للساعة بإستخدام آلة الضباب الحرارى المركبة على دراجة ثلاثية العجلات بسرعة أمامية من 0,6 – 1,2 م/ ث كانت 24,6 - 26,2 جنية/ ساعة، 0,20 - 0,26 جنيه/شجرة و1,96 - 2,41 جنيه/طن بإستخدام مادة التحكم "KZ".