African Journal of Agricultural Research Vol. 7(47), pp. 6329-6334, 13 November, 2012
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897/AJAR12.112
ISSN 1991-637X ©2012 Academic Journals

Full Length Research Paper

Effect of physic-chemical parameters on the infestation of fruits by *Ceratitis capitata* WIEDDEMANN, 1824 (Diptera: Tephritidae)

F. METNA, D.SADOUDI-ALI AHMED*, B. METNA and F. MEDJDOUB

Faculté des Sciences biologiques et agronomiques, Université M. Mammeri de Tizi-Ouzou, Algeria.

Accepted 31 October, 2012

To determine the effect of some physic-chemical parameters of fruits such as fruit weight, fruit diameter, thickness and the essential oil content of the peel, we followed the infestation by *C. capitata* Wied. 1824 (Diptera:Tephritidae), of ten fruit varieties: Oranges Thomson, Hamlin, Double Fine and Valencia late, lemons quatre saisons, apricot Bulida peaches Cardinal and Redhaven and figs Taghanimth, and Thâamrount. The physical-chemical parameters of fruits (weight, diameter, thickness of the bark and essential oil yield) are significantly correlated. They are negatively correlated with the average number of pupae / fruit. No correlation was observed between these parameters and the rate of fruit attacked and the number of attack per fruit.

Key words: Medfly, preference, essential oils, weight, diameter, thickness of the peel, fruit variety.

INTRODUCTION

The fruit fly of the Mediterranean, *Ceratitis capitata* Wied., 1824 (Diptera: Tephritidae) is a highly polyphagous insect. It operates on different fruit species ripening in successive times, such as citrus, apricots, peaches and figs.

Males of the medfly congregate in groups on the plants; they emit together a sex pheromone attracting females. After mating, begins egg laying, which is strongly influenced by light intensity (Quilici, 1999). After the eggs are hatched, the larvae feed on the fruit fresh. The third instar larvae leave the fruit and pupate in the soil. From these pupae emerges adult which starts the cycle again.

Delrio (1985), Dhouib et al. (1995) and Ronald et al. (1995) believe that the most important criteria that can significantly influence the degree of infestation and the development of the fruit fly are the volume of the fruit and the thickness of its peel. According to Balachowsky and Mesnil (1935) and Delanoue and Soria (1962), larval mortality in *C. capitata* may be caused by the oily texture of the peel of some fruit.

Our study focuses on determining the effect of some physico-chemical parameters of fruit on the average rate of infestation by *C. capitata*. Ten fruit varieties trees belonging to five different species have been the subject of our study. These are the varieties of orange Thomson, Hamlin, Valencia Late and Double Fine, lemons quatre saisons, apricot Bulida, peach Cardinal and Redhaven and figs Thâamrount and Thaghanimth. All these species are included in the list of host plants of the Mediterranean fruit fly.

We worked on summer fruit varieties and winter varieties maturing in successive time. Some physical characteristics of fruits of some varieties were studied to know the fruit weight, diameter and thickness of the peel. In addition to physical characteristics, we studied a different character from the peel of the same varieties of fruits which is the rate of essential oils present in the fruit peel, basing on the method of hydrodistillation (International Standard. Ref., Norme 1955 = ISO 1982). The purpose of this study was to reveal any correlation

*Corresponding author. E-mail: daliahmed@yahoo.fr

between the intensity of infestation caused by the Mediterranean fruit fly and some physico-chemical properties of fruits.

MATERIALS AND METHODS

This work was carried out in 17 orchards located at Tizi-Ouzou (100 km east of Algiers) and Boumerdes, which is located in north central Algeria (40 km from Algiers).

Sampling of fruits

To assess the degree of infestation of different fruit species, we conducted a sampling of fruits. The fruits were collected at maturity, at the time of harvest. Each variety of fruit is taken from four different orchards. For each variety of fruit and in each orchard study, a sample of 25 fruits is done on trees with different cardinal exposures (east, west, south, north and center) of the parcel to be sampled. The total of each sample is composed of 125 fruits. To determine the effect of physic-chemical parameters on the average rate of infestation by *C. capitata*, 50 other fruits were collected, that is, 2 fruit per tree for all varieties.

Estimated damage by the rate of fruit attacked and the number of attack per fruit

In the laboratory, we proceeded to count the fruit fly attack. This is indicated for each fruit species and for each exposure, the percentage of attack and the average number of punctures (caused for occasion of the oviposition) per fruit.

Estimated damage depending on the number of pupae per fruit

The fruit of each variety and each exposure were separately placed in strainers, the latter placed in turn in basins containing about 2 cm of sand used to collect the pupae. The strainers are covered with a muslin mesh whose diameter is less than that of drosophila, attracted by the fruit fermentation. The pupae are collected every 48 h by sieving the sand

Physical parameters of fruits

To determine the effect of some parameters on the average rate of infection by *C. capitata*, some characteristics of the fruits of some varieties were studied, namely, fruit weight, diameter, thickness and the concentration of essential oils of the bark.

Fruit's weight

Once in the laboratory, we weighed each fruit.

Diameter of fruit

Once the fruit are weighed using a caliper, we measured the diameter of each fruit. Two diameter measurements were made for each fruit. The same measurements were made for the 25 fruits of each variety.

Peel thickness

The thickness of the peel of the fruit is estimated using a caliper (paquímetro digital?). Three different measures have been made for each fruit peel. The same measurements were made for the 25 fruits of each variety.

Essential oil content of fruit peel

The principle consists of boiling a sample, whether diluted or not, and drive water vapour essential oils. For lack of graduated pipette, the distillate obtained is introduced into a funnel. After purification, we recover the oil in a previously weighed beaker and then we weight the product obtained in order to estimate the yield (Bachelot et al., 2006). We recovered the peel of 50 fruits that we dried in the outdoors and darkness, and then crushed. We weighed 100 g of crushed that we have introduced in the flask of the steam distillation with water. We made two determinations on the same sample.

RESULTS

Estimation of fruit infestation of different studied varieties

Rate of attack fruits

From the results we note that the rate of fruit attacked differs from one fruit variety to another. A maximum of 49.2% was recorded for the orange Thomson variety and a minimum of 13.2% was recorded for orange Double fine variety (Figure 1).

Number of punctures per fruit

The average number of punctures per fruit varies from 0.23 (orange Double fine variety) to 1.00 (Orange Hamlin variety) (Figure 2).

Number of pupae per fruit

The average number of pupae per fruit ranges from 0 for different varieties of citrus to 2.04 pupae/fruit for fishing Redhaven variety (Figure 3).

Characteristics of fruits of the different studied varieties

Fruit weight

The average fruit weight ranged from 27.24 g (minimum value recorded for the fig Thaghanimth variety) to 249.44 g (maximum value recorded for the orange Thomson variety) (Table 1). The results presented in Table 1 show that the average weights obtained vary around an overall average of 124 g. the varieties of oranges and the lemon variety is characterized by weight average above the global average, while the varieties of apricot, peach and fig are determined by lower average weight of 124 g.

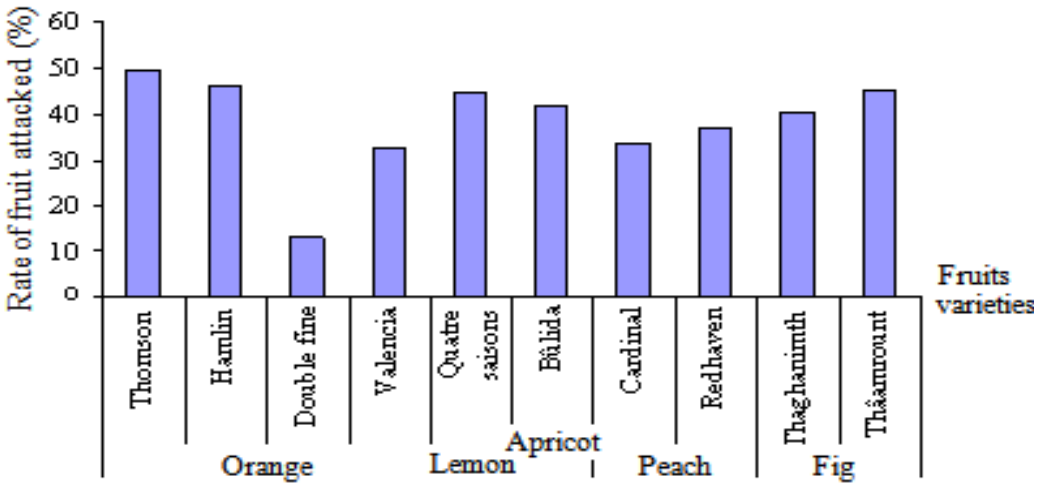

Figure 1. Average rate of attack fruits of the different studied varieties of fruits.

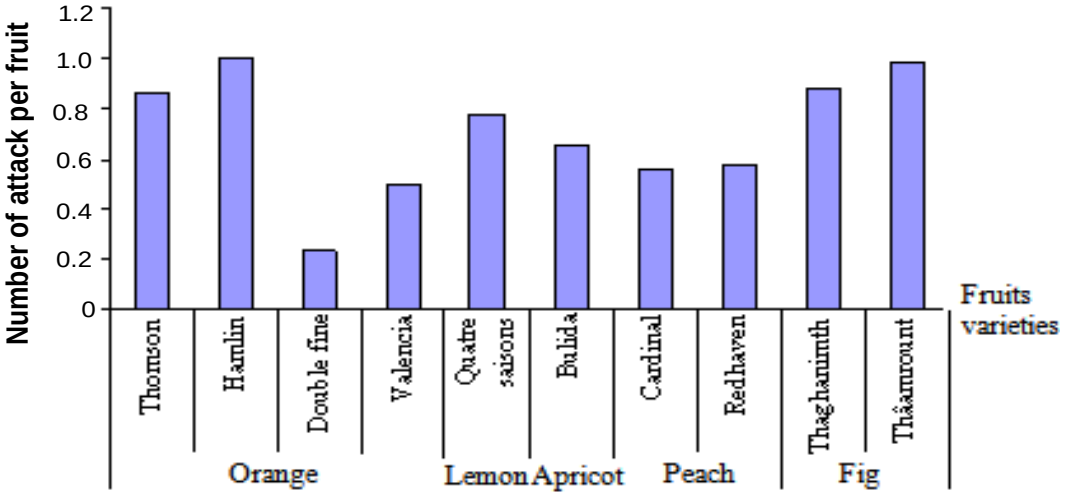

Figure 2. Average number of attack per fruit for different studied varieties of fruits.

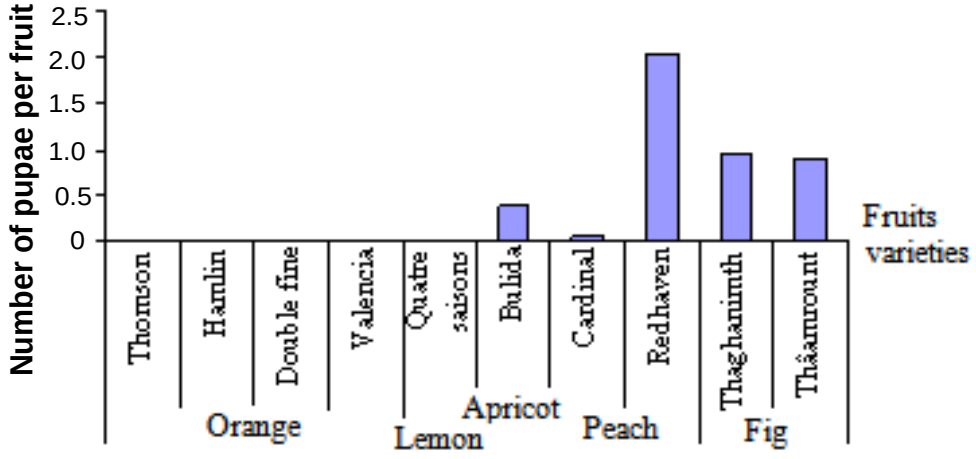

Figure 3. Average number of pupae per fruit for different studied varieties of fruits.

Table 1. Physico-chemical parameters of fruits (weight, diameter, peel's thickness and essential oil yield).

Fruit specie	Varieties	Weight (g)	Diameter (mm)	Peel's thickness (mm)	Essentiel oil yield (%)
Oranges	Thomson	249.44	81.59	4.44	2.17
	Hamline	188.79	71.59	3.84	3.21
	Double fine	178.63	69.34	4.45	0.89
	Valencia	166.5	67.9	3.25	3.26
Lemon	Quatre saisons	135.01	58.92	4.45	2.83
Apricot	Bulida	65.00	47.89	0.34	0
Peaches	Cardinal	108.37	58.38	0.41	0
	Redhaven	92.09	53.14	0.40	0
Figs	Thaghanimth	28.84	35.89	1.42	0
	Thâamrount	27.34	34.18	1.39	0
Average		24	57.88	2.44	1.24

Fruit diameter

We noted that the average diameter of fruits studied ranged from 27.34 mm for the fig Thâamrount variety to 81.59 mm for the orange Thomson variety (Table 1).The citrus varieties studied are characterized by average diameters greater than the overall average: 57,88 mm. whereas the diameters of different varieties of peach, apricot and fig are below overall average.

Peel's thickness

From the results presented in Table 1, we distinguished that the average thickness of the peel of various studied fruit varieties oscillates around an overall average of 2.44 mm. It varies from 0.34 mm for the apricot Bulida variety to 4.45 mm for the orange Double fine variety and lemon Quatre saisons variety.

Essential oils

The estimate of the average yield of essential oils of the bark of various fruit studied varieties show that it varies from 0% for summer varieties to 3.26% for the orange Valencia variety (Table 1).

Correlation between parameters of infection and the physic-chemical characteristics of fruits

We performed a matrix correlation between the parameters of infestation (the rate of fruit attacked, number of attack / fruit and number of pupae / fruit) and characteristics of the fruits (weight, diameter, peel thickness, yield essential oils from the peel of various studied fruit varieties). From the matrix correlation presented in Table 2, we deduce that the rate of fruit attacked is positively correlated with the average number of attack per fruit. These two parameters are not correlated with the average number of pupae per fruit and the physico-chemical parameters of the studied fruits.

DISCUSSION

From the results obtained about the estimation of fruits infestation by the rate of fruits attacked and the number of attack per fruit, we found that the orange Thomson and Hamlin variety were the most infested comparing to the other studied fruit varieties. Thomson is the variety characterized by a rate of fruit attacked of 49.2% and the Hamlin variety is represented by 46% of fruit attacked with an average of one puncture / fruit. This is probably due to several parameters such as essential oils content of the peel and the nature of volatile substances that could play a significant role in the attraction or repulsion of the pest (Dhouib et al., 1995). Thierry et al. (1999) showed that visual recognition of the host by the fly depends on the fruit shape and color.

The same observation is underscored by Katsoyannos (1986) according to whom wild females are attracted by yellow spheres, while the orange, green and red, are less attractive. He also deduced that the response to yellow spheres is the normal response to the stimulus exerted by the color of the oviposition site. The fig Thâamrount variety comes just after, with a rate of fruit attacked of 45.07% and an average of 0.98 punctures / fruit. Hendrich and Hendrich (1990) and Alemany et al. (2006), consider fig fruit as the most preferred of the fruit fly compared to oranges because of its rich food especially sugar.

The orange Double fine and Valencia varieties were the least infested. The latter presented a rate of fruit attacked by 13.2% and 0.23 punctures / fruit for the first variety,

Table 2. matrix Correlation between the parameters of infestation and the physico-chemical characteristics of fruit

	Rate of fruit attacked	Number of attack / fruit	Number of pupae / fruit	Weight	Diameter	Peel's thickness	Essential oil yield
Rate of fruit attacked	1	0.90*	0.27	0.00	-0.03	0.09	0.15
Number of attack / fruit	0.90*	1	0.28	-0.09	-0.12	0.11	0.08
Number of pupae / fruit	0.27	0.28	1*	-0.45*	-0.44*	-0.41*	-0.40*
Weight	0.00	-0.09	-0.45*	1*	0.97*	0.73*	0.67*
Diameter	-0.03	-0.12	-0.44*	0.97*	1*	0.68*	0.64*
Peel's thickness	0.09	0.11	-0.41*	0.73*	0.68*	1*	0.74*
Essential oil yield	0.15	0.08	-0.40*	0.67*	0.64*	0.74*	1*

*, Significant at alpha = 0.0.

44.8% and 0.5 punctures / fruit for the second variety. 44.8% and 0.5 punctures / fruit for the second variety. The orange Thomson variety gets more punctures than later varieties; this can be explained as reported by Quilici (1993) by the attraction exerted by Thomson which is due to volatile components emitted well before fruit maturity. These components are olfactory stimuli for the fruit fly.

Although the rate of fruit attacked and the number of attack per fruit are high on the different varieties of citrus, no pupae is recovered from these varieties. The larval mortality of Mediterranean fruit fly on certain varieties of citrus such as oranges has been the subject matter of the work done by Delanoue and Soria (1962). They attributed this to several factors, including:

(1) The oily texture of the peel of fruit
(2) The low temperatures that occur during the ripening of fruit
(3) The rate of moisture decreases with the maturity of the fruit.

Delrio (1985) added that on citrus, eggs and larvae have a very high mortality due to toxicity of the skin. Unlike the various citrus varieties, the number of pupae recovered from the peach Redhaven variety and varieties of fig Thaghanimth and Thâamrount is 2.04 pupae / fruit, 0.97 pupae / fruit and 0.92 pupae/ fruit, respectively. The variety of peach Redhaven is the fruit which gave the greater number of pupae. Ali Ahmed-Sadoudi (2007) has classified this variety among the largest fruit infested by the Mediterranean fruit fly. According to the same author, the fruit of this variety showed low level of vitamin C and high level of reducing sugar and protein.

It is also clear from our results that the citrus varieties are positively correlated with weight, diameter, peel thickness and yield of essential oils. Their fruit gave no pupae. According to Soria (1963) and Dhouibi et al. (1995), larval mortality in Citrus, especially oranges, could be due to the chemical composition of the fruit peel. Experiments have shown that larval mortality in *C. capitata* may be increased if the skin is too thick. It is variable thicknesses ranging from 4 to 8 mm, but beyond 8 mm mortality increases with the thickness, from 81.8% to 8 mm. It increases to 100% for 11, 12 mm and more (Bodenheimer, 1951; Delrio, 1985).

Concerning the different varieties of peach, apricot and fig, are characterized by a less bulky fruit. However, it is from these latter that we have recovered a large number of pupae. The fruits of these varieties showed the lowest layers of peel and lowest yields of essential oils.

In conclusion, parameters of fruits such as weight, diameter, peel thickness and yield essential oils are significantly correlated. However, they are negatively correlated with the average number of pupae / fruit. No correlation was observed between these parameters and the rate of fruit attacked and the number of attack / fruit.

REFERENCES

Alemany A, Miranda M A, Alonso R, Martin Escorza C (2006). Changes in the spatial and temporal population density of the mediterranean fruit fly (Diptera: Tephritidae) in a citrus orchard. Span. J. Agric. Res. 4(2):6.

Ali Ahmed-Sadoudi D (2007). Bioécologie de la mouche méditerranéenne des fruits *Ceratitis capitata* Wiedemann, 1824 (Diptera: Trypetidae) dans quelques vergers de la Kabylie. PHD Thesis, University of Tizi-Ouzou. p. 197.

Bachelot C, Blaise A, Corbel T, Le Guernic A (2006). Les huiles essentielles, Extraction et Comparaison. Licen. 2 Bio. Semes. 2., U.C.O. Bretagne Nord. p. 19 .

Balachowsky AS, Mesnil L (1935). Les insectes nuisibles aux plantes cultivées. Ed. Busson, 1:242-253.

Bodenheimer FS (1951). Citrus entomology in the Middle East. Junk, The Hague. P.663.

Delanoue P, Soria F (1962). Les fruits de l'orange amer *Citrus bigaradia* Risso résérve dangereuse en Tunisie de mouches des fruits *Ceratitis capitata* (Weid.) 35:185-204.

Delrio G (1985). Tephrytid pests in citriculture. CEC/Proc. Experts meeting. Acireale; Balkema. Rotterdam. Integrated pest control in Citrus. Ed. Recher. Cavalloro and E. Dimartino. pp. 135-149.

Dhouibi MH, Gahbich H, Saadia B (1995). Evolution de l'attaque des fruits par *Ceratitis capitata* en fonction de la position sur l'arbre et du degré de maturité des oranges. Fruits 50(1):39-49.

Katsoyannos BI (1986). Effect of color properties on the selection of oviposition site by *Ceratitis capitata.* Entomol. Exp. Appl. 42:187-193.

Norme ISO 1955 1982 (F) : Agrumes et produits dérivés – Détermination de la teneur en huiles essentielles (méthode de référence), first edition – 1982-12-01. p. 3.

Quilici S (1999). La mouche méditerranéenne des fruits ou *Ceratitis capitata* (Wiedmann) (Diptera : Tephritidae), CIRAD France, 44-64.

Quilici S (1993). Programme de recherche et d'action sur la mouche méditerranéenne des fruits à l'île de la Réunion. Fruits 49:28-41.
Hendrichs J, Hendrichs MA (1990). Mediterranean fruit fly, *Ceratitis capitata* (Diptera: Tephritidae) in nature: Location and diet pattern of feeding and other activities on fruitinh and non-fruiting hosts and non-hosts. Annls of the Entomological Society of America 83, 632 - 641.
Ronald J. Prokopy I. and Roger I, Vargas, (1995). Attraction of *Ceratitis capitata* (Diptera: Tephritidae) flies to odor of coffee fruit. J. Chem. Eco. 22(4):807-820.
Soria F (1963). Etude des populations et de dispersion de *Ceratitis capitata* Wied. (Diptera : Trypetidae) en Tunisie à l'aide des radio - isotopes. International Atomic Energy Agency (IAEA) I Vienne. pp. 357-363.
Thierry B, Quilici S, Glenac S (1999). Utilisation des signaux émis par la plante pour piéger les femelles de *Ceratitis capitata.* Phytoma ; la défense des végétaux. N°.515:35-36.