Effect of Alpha-cypremethrin on morphological parameters in tomato plants (*Lycopersiconesculentum Mill.*)

Karim CHAHID[1], Amin LAGLAOUI[2], Said ZENTAR[3], Abdeslam ENNABILI[1]

[1]Laboratoire LAMEC, Faculté des sciences Dhar El Mehraz, Fès

[2]Equipe de Recherche ERBGB, Faculté des Sciences et Techniques, Tanger

[3]Station d'ionisation SIBO de l'INRA, Tanger

Email address:

karimchahid@yahoo.fr(K. CHAHID)

Abstract: Devastating insects are responsible of losses in quantity and quality of agricultural production. To overcome this problem, farmers use pesticides, obtained by chemical synthesis and representing the major cause of agricultural contamination of soil and groundwater. Thus, pesticides may present important risks because of their persistence, bioavailabilityand mobility, in spite of their correct application. This study has evaluated the effect of alphacypermethrin (pyrethroids class), largely used in tomato (*Lycopersiconesculentum* Mill.*)* treatment in the Northern area of Morocco.Synthetic pyrethroids are widely used as the broad-spectrum pest control agents in agricultural production because of their selective insecticidal activity, rapid biotransformation and excretion by the mammalian catabolic system and non-persistence in the environment. The effect of alpha-cypremethrin on seeds germination and seedlings growth of tomato has been studied based on morphological parameters and by using four dilutions of the normal concentration used in agriculture (100%, 75%, 50%, 25%) for germinating seeds, and only the normal concentration used in agriculture for growing tomato plants. The results indicated that alpha-cypremethrin induced a delay of germination and growth process. The germination rate of treated seeds was generally 20% lower than the control treatment. Generally the control's germination rate was around 97% in all days of measurement period. A decrease in germination rate was observed in all concentrations of α-cypermethrin; the rate was between 80% and 88.7% and it was generally constant throughout the test period. Furthermore, the length of roots and shoots in treated seeds was significantly reduced. In this regard, shoot length of the treated seedlings was 25% and 50%-reduced for the concentrations of 25% and 100%, respectively, when compared to control shoots length. A similar result was also observed in roots, the length of the treated seedlings'roots was generally 29% and 50%-reduced for the concentrations of 25% and 100%,respectively, when compared to control roots length. Concerning the growth of roots and shoots in treated plantlets, a reduction was observed when compared to the control plantlets growth. The growth delay in the treated seedlings was observed at the 2nd week of the test period. Shoot length of treated plantlets was generally around 12%reduced when compared to the control. The same result was observed in treated plants' roots which length was also 7% reduced compared to untreated seedlings. The analysis of variance (ANOVA) and the Tukey test were utilised for the Post-hoc tests. A significance level of 0.05 was used for all statistical tests.

Keywords: Insecticides, Tomato, Seed Germination, Plant Growth

1. Introduction

The tomato (*Lycopersicumesculentum* Mill.) is one of the most widely grown vegetables in the world. In recent years, competition has intensified as the world exports of tomato products from main suppliers have increased substantially.

Tomatoes growth can be inhibited by various arthropods, plant diseases and nematodes, which significantly reduce yield and quality of fruit (Oerke*et al,* 1994).

In Northern Morocco, the most important way to protect cropis the use of chemical pesticides. Many pesticide types are used, especially: organochlorine, organophosphorus, carbamate and pyrethroids pesticides

(El Bakouri *et al.*, 2008). However, the use of these pesticides obtained by chemical synthesis represents the major cause of agricultural soil and groundwater contamination because of their persistence, bioavailabilityand mobility (Arias-Estevez *et al.*, 2008). The pesticide occurrence in agricultural soil of the Tangier region shows the presence of many pesticides types such as endosulfan isomers (alpha and beta),endosulfansulfate, some DDT metabolites and alpha HCH (El Bakouri*et al.*, 2008).

2. Materials and Methods

The methodology utilized in the experimental work consisted of: plant material used to prepare the samples and a variety of germination tests; growth evaluation tests; and the different variables monitored and measured for evaluation purposes. Following the implementation of experimental design, a statistical analysis was performed to evaluate the significant level of tolerance and impact. The different experimental steps are discussed below.

The samples were prepared by selecting tomato(*Lycopersicumesculentum* Mill.) seeds from the Vilmorin commercial seeds, which were surface-sterilized in 10% commercial bleach with stirring for five minutes, followed by extensive washing in sterile-distilled water. The germination was initiated by selecting batches of 50 tomato seeds that were germinated in Petri dishes (diameter 9 cm) upon two layers of filter paper moistened with 6 ml of distilled water or insecticide solutions at the concentrations of 25%, 50%, 75% and 100%,where100% represents the normal concentration usually used. The Petri dishes were stored in a growth chamber in darkness at 25°C for six days. At various stages of the tomato seed germination (3, 4 and 5 days), seeds of each replicate were collected for measurement. Three repetitions were

performed. Germination time was determined as the time of rupture of seed coats, and the emergence of the radicle through the seed coat.

For growth evaluation, ten seeds were sown in each plastic pot for germination and growth. Seedlings were grown at 24/20°C (day/night) and 16 hours of light, and watered each day. After growth for 30 days, the seedlings were treated with the insecticides at the normal concentrations used in agriculture (100%). The tests were realised also on the 2nd, 5th, 8th, 11th and 14th day after treatment. Each value represents the average of three replications.

The growth was evaluated by the rate of germination. The germination rate of tomato seeds was evaluated by counting the number of germinated seeds in batches of 50 seeds; each value represents the average of three repetitions. Measurements were made of the length of shoots and roots of the germinated seeds. For the elongation of growing tomato seedlings, the scaled length of shoots and roots was made; each value represents the average of three repetitions.

Following the completion of the experimental sample, the data was evaluated statistically. The data were processed by using Statistica Software (Statistica, 1997) for one-way analysis of variance (ANOVA) and the Tukey test for the Post-hoc tests. A significance level of 0.05 was used for all statistical tests.

3. Results

It was observed that germination rate of treated seeds was lower than the control one as shown in Table1. The control's germination rate was around 97% on all days of the measurement period. A decrease in germination rate was observed in all concentrations of α-cypermethrin; the rate was between 80% and 88.7% and it was generally constant throughout the test period.

Table 1. *Effect of α-cypermethrin on germination percentage of tomato seeds at a significant difference at P≤0.05, 0.01 and 0.001 levels.*

	3rd day	4th day	5th day
Control α-cypermethrin	97.33% ± 1.15	97.33% ± 1.15	97.33% ± 1.15
25%	88.66% ± 1.15***	88.66% ± 1.15***	88.66% ± 1.15***
50%	80% ± 0***	80% ± 0***	80% ± 0***
75%	80.66% ± 2.3***	82% ± 2***	82% ± 2***
100%	88% ± 0***	88% ± 0***	88% ± 0***

Note:*, ** and *** indicate significant difference at *P*≤0.05, 0.01 and 0.001 levels, respectively

Concerning the plantlets growth, a delay was observed for the treated seeds as shown in Table 2. Shoot length of both control and treated seed plantlets increased depending on the time, but the growth of the treated seed plantlets was lower than the control ones. In this regard, shoot length of the treated seedlings was 25% and 50%-reduced for the concentrations of 25% and 100%, respectively.

Table 2. *Effect of α-cypermethrin on shoot and root length in tomato seedlingsindicate significant difference at P≤0.05, 0.01 and 0.001 levels.*

Shoot length (cm)			Root length (cm)		
3rd day	4th day	5th day	3rd day	4th day	5th day
Control 0.81 ± 0.09 α-cypermethrin	1.84 ± 0.09	2.96 ± 0.12	2.01 ± 0.14	2.81 ± 0.17	3.59 ± 0.07
25% 0.62 ± 0.02	1.19 ± 0.08**	1.64 ± 0.1***	1.31 ± 0.08***	2.02 ± 0.14***	2.41 ± 0.15***
50% 0.49 ± 0.08**	1 ± 0.25***	1.26 ± 0.33***	1.14 ± 0.08***	1.97 ± 0.16***	1.92 ± 0.21***
75% 0.5 ± 0.05**	0.9± 0.15***	1.3 ± 0.22***	1.26 ± 0.01***	1.57 ± 0.12***	2.05 ± 0.21***
100% 0.44 ± 0.07***	0.93 ± 0.17***	1.24 ± 0.08***	1.1 ± 0.03***	1.79 ± 0.05***	1.95 ± 0.14***

Note:*, ** and *** indicate significant difference at $P≤0.05$, 0.01 and 0.001 levels respectively

A similar effect was also observed in seedlings root growth. The delay of roots growth was at the same order as the delay observed in shoot growth. Root length was around 3.6 cm in control plantlets on the 5th day and 2.41 cm in treated ones (25%-α-cypermethrin, 5th day) as shown in Table2.

Table 3. *Effect of α-cypermethrin on shoot and roots length in growing tomato seedlings. *,** and *** indicate significant difference at P≤0.05, 0.01 and 0.001 levels.*

	Shoot length (cm)		Root length (cm)	
	Control	α-cypermethrin	Control	α-cypermethrine
2nd day	18 ± 1	17.9 ± 0.65	22.8 ± 0.7	22.56 ± 0.81
5th day	18.5 ± 0.5	18.13 ± 2.51	23.5 ± 0.58	23.3 ± 0.1
8th day	19.23 ± 0.25	18.43 ± 0.32*	24.5 ± 0.72	23.9 ± 0.4
11th day	20.4 ± 0.36	18.9 ± 0.6*	25.6 ± 0.28	24.13 ± 0.47**
14th day	22.1 ± 0.62	19.6 ± 0.95*	26.7 ± 0.17	25 ± 0.55**

Note:*, ** and *** indicate significant difference at $P≤0.05$, 0.01 and 0.001 levels respectively

Furthermore, evaluation of length progression of growing seedlings shows a growth delay in the treated seedlings at the 2nd week of the test period. Shoot length of treated plantlets was around 19.6 cm as opposed to 22.1 cm for the control ones as shown in Table3. Root length of treated plantlets was also lower and reached25 cm, as opposed to26.7 cm in untreated seedlings as shown in Table3.

4. Discussion

The percentage of germination may reflect the reaction rate of plant seeds to their living environment (Li *et al.,* 2007). The results obtained in this study illustrate an inhibitory effect of germination after treatment by the α-cypermethrin at various concentrations. In literature, a decline in seed germination rate (more than 50 %) have been reported for other pesticides such as paraquat dichloride (l,l'-dimethyl-4,4'-bipyridinium dichloride) at 1.0 mg/L in *Typhalatifolia* (Moore *et al.*, 1999). A similar effect was also shown in *Triticumaestivum*, treated by using heavy metals (5–20 mg/kg of Arsenic) (Li *et al.,* 2007).

The general symptom of plants under such stresses is growth inhibition (Yang *et al.,* 2001; Wang *et al.,* 2004; Wang and Yang, 2005). It was observed that the tomato seeds plantlets and seedlings growth was significantly delayed after insecticide application, affecting the plantlets shoots as well as roots. However, many studies reported an inhibitory effect of growth after application of pesticides: (i) around 50%-decreasing of root growth in *Phaseolus vulgaris* and *Pisumsativum* after treatment with chlorsulfuron during the germination process (Fayez *and* Kristen, 1996), and (ii) low root growth in *Zea mays* seedlings in the presence of pesticides such as chlorsulfuron and metsulfuron methyl (Fayez *et al.,* 1994). This effect was also demonstrated with other xenobiotic types like heavy metals. Khatun*et al.* (2008) underlined a severe growth inhibition of shoots and roots in *Withaniasomnifera* because of copper contamination.

Many hypotheses could explain this delay of growth in treated plants and seedling.

Firstly, insecticides could induce damages in the meristematic cells; in this way, Fayez and Kirsten (1996) showed that chlorosulfuron has an obvious influence on the

cellular structure of root caps of *Pisumsativum, Phaseolus vulgaris* and *Viciafaba*, and induce a reduction of root cell division, delaying the root growth (Ray, 1982; Rost, 1984).-

On the other hand, insecticides could affect the photosynthetic system by the inhibition of photo system II and chain electron transport activities, as reported for example by Mishra *et al.* (2008) in *Vignaunguiculata* when treated by dimethoate. Pesticides could also lead to a delay in photosynthetic pigments rates such as chlorophylls (Mishra *et al.,* 2008).

Moreover, in literature, the delay of growth was reported as an indicator of oxidative stress (Yang *et al.,* 2001; Wang *et al.,* 2004; Wang and Yang, 2005). Generally, the plants cells produce the ROS as a second messenger in some processes of growth and development (Grun *et al.,* 2006; Schurmann, 2003 ; Borland *et al.,* 2006). There is an interaction between activation and repression of reactive oxygen species (ROS) and phytohormones (Delledome *et al.*, 2003; Terman*and* Brunk, 2006; Del Rio *et al.,* 2006; Shao *et al.,* 2006, McCarty *and* Chory, 2000; Shao *et al.,* 2008). When the plant is under an oxidative stress, the excess of ROS production could lead to growth perturbations.

In perspective, other studies on insecticides effect in tomato are undertaken: reserves substances, enzymes degradation and oxidative stress.

5. Conclusion

To summarize, the insecticides studied showed a negative effect in both tomato seeds and growing plants. The insecticides influenced both germination and growth process by causing a decrease in germination rate and delay inlength progress of treated shoots and roots in both seeds and plants. Other studies are undertaken to have a clear idea about the effect of insecticides in tomato**.**

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