THE PHYTOTOXIC EFFECTS OF METHOMYL AND IMIDACLOPRID INSECTICIDES ON TOMATO LOCAL VARIETY IN AL-HASSA, SAUDI ARABIA

M. JAMAL HAJJAR, MOHAMAD S. ALSAIKHAN and AHMED M. SOLIMAN

College of Agriculture and food Sciences. King Faisal University, KSA

Abstract

Imidacloprid and Methomyl are systemic insecticide used widely for controlling insects infesting crops grown in greenhouses. The experiment was conducted on tomato (Hassawi, Local Varity in Eastern part of KSA) to study the phytotoxicity effect of the tested insecticides at various application rates. Imidacloprid was tested at (25, 50, 100, and 150 a.i g/100 L), and Methomyl at (15, 35, 50 and 70 g a.i /100L). Both insecticides caused phytotoxicity to treated leaves, the symptoms of leaf chlorosis of the old leaves and distorted growth and marginal necrosis of newer leaves was developed after 3 days of application with the highest rate for both insecticide experiments, but with the rest of application higher than the lowest and recommended rate, the phytotoxicity symptoms were developed within the second week of application. The size of the new shoot was significantly affected by high rate of application for both Imidacloprid and Methomyl, and that was reflected in the reduction of the weight of dried shoot. In case of old leaf, despite the significant differences between the treatment but the reduction in dry weight in correlation with application rates were small. However, the lowest application rates of both tested insecticides showed a positive stimulation in the new growth that emerged after treatments, even though the lowest rate at 25 g a.i of Imidacloprid caused some phytotoxicity symptoms by the end of the experiment. The results indicated the higher phytotoxicity of Imidacloprid Than Methomyl and the higher application rate had a significantly higher phytotoxicity than the lower application rate. It appears that the foliar treatments of Methomyl or imidacloprid did not altered plant nutrition, except the highest rate of imidacloprid which was varied quadraticaly at the highest rate of application. The excess of the insecticides as results of foliar application cause senescence and not alteration in nutrient content in the treated leaves, because the imidacloprid or methomyl insecticides are directly catabolized by the plant. Thus, differences in plant nutrition are likely a result of influence of insecticide application and not a cause of the phytotoxicity symptoms.

INTRODUCTION

Phytotoxic means harmful or lethal to plants. Phytotoxicity is the degree to which a chemical or other compound is toxic to plants. All types of pesticides can injure or kill plants. Herbicides are especially hazardous to plants because they are designed to kill or suppress plants. Some insecticides and fungicides can also harm plants.

Phytotoxic effects caused by herbicides can be from spray droplets, soil residues or vapors and can be move off target in water or soil contacting sensitive plants. (Özlem Aksoy, *et al.* 2013) investigated the phytotoxic effects of phenoxy herbicide Quizalofop-P-Ethyl (QPE) in Soybean. The Morphological and anatomical experiments were carried out using the QPE at EC50 concentrations of 0.4 M and 0.8 M (EC50x2) on 5th and 10th days, with spraying method in 2-3 leaf stage. QPE exposure significantly reduced the amount of carotenoid and chlorophyll b pigments except of chlorophyll a in all treatment. Parallel to the increase in concentrations of QPE, there was a reduction in root and seedling length and also the lengths of the anatomical parts of seedlings were changed. The insecticides placed in soil treated with herbicides cane in some cases cause severe damage to the plant. (Freeman 1978) found The combinations of the herbicide Eradicane and Fonofos (insecticide) caused malformation of sweet corn ears. The injury ranged from slight to severe curvature of the ear together with shortening and twisting of the husk. The injury on corn hybrids also reported after application of terbufos insecticide at 1.1 kg ai ha-l in-furrow, following the post emergence herbicide application of sulfonylurea and injury was increased with increasing the herbicide rate (Holshouser, et. al. 1991). The insecticide phytotoxicity potential on sugar beet (Gary and Wilson 1995) also reported with great injury, when the insecticide chlorpyrifos, fonofos and terbufos placement in soil treated with Cycloate herbicide.

Phototoxic properties of pesticides are usually associated with specific formulations (wettable powder, emulsifiable concentrate, granule, etc.) or specific plants rather than groups of pesticides or plants and may list plants or varieties that are sensitive. Coarsery, (1954) reported that the ornamental plan, Hibiscus was injured by high concentration of Malathion and Parathion, and in some observation indicated that the Hibiscus in need of water are more susceptible to insecticidal injury than those that was well watered prior to spraying. Hata and Hara (1988) recorded the phytotoxicity of insecticides and acaricide such as Dursban in all tested formulation (EC, WP and ME) and Vydate liquied, Kelthane EC and isotox isect killer on Anthurium cultivars, the typical phytotoxic responses were chlorosis, necrosis, bronzing, molting, abnormal growth and leaf drop. Furthermore, in most cases none of common used insecticides showed any phytotoxic effects, when applied to plants at standard. On 2-4 year old Sitka spruce, the chlorpyrifos , Dimethoate and malathion at x1 rate didn't showed any phytotoxic effects, and even the treated trees at standard rate were even slightly growth promoting compared with control trees. however, Savona (insecticidal soap) as foliage sprays caused needle browning. furthermore, applications at twice the standard rate resulted in a range of phytotoxic effects, Dimethoate and malathion at the Xl rate increased shoot growth, whereas malathion at X2 and the combination of two pyrethroids Pynosect (pyrethrum + resmethrin) at Xl and X2 were noticeably phytotoxic, (Straw, et. al. 1996; Straw and Fieldimg, 1998). The phytotoxic effects of selected bio-insecticides, and insecticides were studied by (Cycholl, 2002) on Spanish lavender, oregano, rosemary, wolly thyme, and nutmeg thyme. Pyrethrin, potassium salts of fatty acids، and both rates of cinnamaldehyde were consistently more phytotoxic than the other insecticides, but the bio-insecticide Beauveria bassiana Strain, and the plant extract of Azadirachtin, Capsaicin and Paraffinic oil at recommended rate didn't caused any phytotoxicity to treated herbs. However, some natural plant extract of insecticides may cause some injury to treated plant and that dependence on the plant variety, stage and way of application. Clove oil has demonstrated toxicity to insects and weeds, Meyer et. al. (2008) reported that, tomato seedlings were the most sensitive to clove oil when it is applied as drenches to soil before transplant of cucumber, muskmelon , pepper , and tomato seedlings. The 0.2% and 0.3% clove oil concentrations at transplant (0 day) were the most phytotoxic to seedlings of all the tested vegetable species, with only 0% to 50% seedling survival.

the phytotoxic effects of some insecticides may presented in negative influences on the growth rate of treated plant. On pearl millet, Phorate caused the most phytotoxicity, reducing seedling emergence to less than 7% and shoot weight to ١٢ mg per seedling (17% of the non-treated control), (Kennedy 2002). This effect also reported on cucumber and tomato were treated with Imidacloprid, 1% granular, both species developed phytotoxicity symptoms of leaf chlorosis of the oldest leaves and distorted growth and marginal necrosis of newer leaves within 1 week after application(Ebel, et. al. 2000). Some insecticides caused alterations in the expression of the fore mentioned enzyme, as reported by (García-Hernández et. al. 2005) the organophosphoric insecticides (parathion, Gusathion, tamaron and active ingredient of metamidofos) had used and effect on the physiology (peroxidase activity) of hot pepper was studied. The results show that the highest insecticide rates caused alterations in the expression of the fore mentioned enzyme. Differences were found among insecticide, but all of them increased enzyme activity when applied at rates higher than those recommended. In other hand, the insecticides may alerting the plant nutrition (Ebel, et. al. 2000) found that in the tomato and cucumber plant treated with Imidacloprid the content of Mg and B decreased and K and Mn increased in both plants.

The use of organ-chlorine resulted in soil contamination worldwide, and also could cause some injury to the treated plant. (Somtrakoon and Pratumma, 2011) reported, that on the early growth stage of sweet corn, waxy corn, cowpea, and cucumber. In the range of concentration found in Thai agricultural soil, 0.4 – 40 mg kg-1 of Heptachlor and Endosulfan sulfate, did not affect the percentage of seed germination. Heptachlor seemed to affect the shoot and root length of test plants more than Endosulfan sulfate. There was no significant effect on combined treatment of both pesticides to corn growth.

Phytotoxic effects can range from slight burning or browning of leaves to death of the plant. Sometimes the damage appears as distorted leaves, fruit, flowers or stems. Damage symptoms vary with the pesticide and the type of plant that has been affected. A pesticide label may indicate whether the pesticide could be phytotoxic, (Short, 1981).

MATERIALS AND METHODS

Tomato Experiment. The experiments were conducted in 2014 in glasshouse at the king Faisal university, Alhassa, KSA. Day/night, temperatures are controlled at 25 + 2 °C, Relative humidity never was below 40%.

On 1st March 2014, Local (Al-hassa) tomato seedlings were obtained from a commercial nursery and transplanted into 4.5 inch. Plant in the containers were grown in peat moss (75% by vol.) with the rest consisting of native fine sand , perlite, and vermiculite. The plants well-irrigated for a 2-week period to recover from transplant. Plants were fertilized with the irrigation water every four days for 4 weeks with 20 mL each of a 20–8.3–8.8 (N–P–K) (Amcofert , KSA) nutrient solution at a concentration of 100 mg/L (ppm) of nitrogen. Four weeks after transplanting, ninety plant of were selected for uniformity. The experiment was conducted as a randomized complete block design, with eight blocks, four imidacloprid treatments and four Methomyl treatments, each treatment conducted with 5 plants replications. The remaining of The 5 seedlings was served as untreated controls. Imidacloprid experiment (Imidor 200SL , Astrachem) was carried out with four treatments, started from the recommended rate of 50g a.i /100 L water, and (25, 100, and 150 g/100 L). The treatments of Methomyl (Lanomar, 90%, Shandong, China) was started with the recommended rate of 35 g a.i /L water and (15, 50 and 70 g/100L.) the insecticide dilution of each treatment was thoroughly sprayed onto each seedling to run-off. Plants were watered regularly in order to minimize plant stress, as environmental conditions, such as low air speed or high relative humidity, and cultural stresses may predispose plants to phytotoxicity (Davidson et al., 1991). In addition, all spray applications were performed in the morning so that any phytotoxic effects were due directly to the insecticides.

Data collection of visual symptoms: Chlorosis of the oldest leaves was estimated by light absorption at 650 nm and 940 nm and measured at 1- to 3-d intervals after treatment for 15 days, using a SPAD light meter (model 502, Minolta, Japan). Tomato plants were evaluated 15 day after treatment on which corresponded to 15 d after treatment applications, visual evaluations were carried out to the injury of leaf surface area. Plants were individually evaluated for phytotoxicity. A numerical phytotoxicity rating scale from 0 to 3 [0 = no visible injury; 1 = light injury, 25% foliar injury ; 2 = moderate injury, 50% foliar injury; and 3 = complete foliar injury, >75% foliar injury] was used to describe the extent of phytotoxicity from the insecticide treatments. This numerical rating scale is similar to the one used by Poe

(1970). Typical plant injury on plants expressing phytotoxic symptoms was a marginal leaf burn (necrosis)

Data collection of physiological diagnosis: At 15 days after treatment and after plant evaluation, all leaves and shots in each plant (replicate) were removed from the stems and the Necrotic areas of leaves were excised using a surgical scissors and the newly growing Leaves were separated from old leaves in the tomato experiment and 10 g of leaves of each type with every replicate in the treatments were taken . leaves and shoots were dried for 48 h at 167 to 185°F (75 to 85 °C) and weighed. the Dried leaves were ground in a Wiley Mill, and then the powder of dried leaves of each treatment were mixed thoroughly and sample of 5 g was taken for determination of a total nitrogen (N) and nutrient content. The samples were analyzed by using atomic absorption technic,

STATISTICAL ANALYSIS. Data were analyzed as a randomized complete block design. Analysis of variance on tomato plant x 2 insecticides × 4 treatments with 5 replicate seedlings in each treatment to determine the mean phytotoxicity rating for each treatment and effect on dry weight. When treatments were significant, means were separated using Duncan's multiple range test at $P< 0.05$.

Analysis of covariance (two-way ANOVA) in randomized blocks represented the interaction between the treatment and day on the chlorophyll using LSD of mean at (5% level).

Significance of linear, quadratic polynomial were determined to ascertain the trend of nutrition plant responses across the treatments (SAS 9.3, 2007)

RESULTS AND DISCUSSION

In experiment of imidacloprid and Methomyl, all treatments were significantly phytotoxic to tomato's leaves of Al-Hassa local tomato Varity (Hassawi) as compared to the control (plant treated with water only) (Table 1). The phytotoxic symptoms reported on treated tomato's leaves were Leaf chlorosis, leaf marginal necrosis, and reduced shoot growth and those was similar to that reported by (Natick 1996, and Ebel *et al.* 2000; Kennedy 2002). The high rate of application had a significantly higher phytotoxicity rating than the lower rate . Methomyl and imidacloprid at recommended application rate were moderately phytotoxic to tomato leaves. However, the lowest application rates of both tested insecticides, showed a positive stimulation in the new growth that emerged after treatments, even though the lowest rate at 25 g (a.i) of Imidacloprid caused some phytotoxicity symptoms, by the end of the experiment, table (3 & 4). the positive influences of some insecticides at standard application rate was already reported on the growth rate of Sitka spruce plant (Straw and Fieldimg, 1998).

Table (1) Mean phytotoxicity rating for Methomyl and Imidacloprid insecticide treatments on leaves of local tomato (Hassawi), the experiment with five replications per treatment per each

Methomyl		Imidacloprid	
Treatment	Mean of phytotoxicity rating ± SD	Treatment	Mean of phytotoxicity rating ± SD
Control	0.000 ± 0.000 a	Control	0.000 ± 0.000 a
M 15 g	0.000 ± 0.000 b	25 g	1.200 ± 0.447 b
M 35 g	2.400 ± 0.548 c	50 g	2.200 ± 0.837 c
M 50 g	2.600 ± 0.548 c	100 g	2.600 ± 0.548 cd
M 70 g	2.600 ± 0.548 c	150 g	3.000 ± 0.000 d

Means not followed by a common letter are significantly different (P = 0.05) as determined by Duncan protected least significant difference (LSD) test.

Analysis of variances between the groups of the Methomyl treatments and the groups of Imidacloprid treatments of the dry weight of the new shots, new leaves and old leaves showed a highly significant statistical indication of all treatment table (2). The treatments with rate less than the recommended application rate in both Methomyl and Imidacloprid experiments reported in a appositive influences on the shoot that emerged following the treatment, and that was reflected by increasing in the weight of the dry shoots table (3 &4). Moreover, despite the phytotoxic effects from some of the higher rates of application, the new growth that emerged following treatments appeared to overcome the initial injury, but the size of the new shoot was affected and that was reflected in the reduction of the weight of dried shoot. In case of Imidacloprid the results in table (4) showed a significant reduction in the dry weight of shoot at the recommended rate of 50 g/100L water and above as compared to control and 25 g/100L. and no significant differences were reported between these three highest rate of Imidacloprid treatments. Whereas in Methomyl insecticide experiment, the results in table (3), showed a non-significant difference in the shoot dry weight between the control and the all treatment except the highest rate of 70 g which was significantly different to the control and lowest rate but not to the other rates of applications. This results indicated the higher phytotoxicity of Imidacloprid Than Methomyl and the higher application rate had a significantly higher phytotoxicity than the lower application rate. The phytotoxicity of doubling and tippling the recommended application rate has been reported with many different type of pesticides and on various crops and this effect was extended to affect the shoots and growth of plant (Straw, 1996; Straw and Fielding, 1998; Kennedy, 2002).

Table. (2) Analysis of variances between the groups of the Methomyl and Imidacloprid treatments on the dry weight of the new shots, new leaves and old leaves of treated tomato.

ANOVA Between Groups	Methomyl experiment					Imidacloprid experiment				
	Sum of Squares	df	Mean Square	F	Sig.	Sum of Squares	df	Mean Square	F	Sig.
New Shoots	0.012	4	.003	7.055	0.001	0.015	4	0.004	18.301	0.000
New leaves	3.268	4	.817	8.208	0.000	6.365	4	1.591	17.827	0.000
Old leaves	0.374	4	.094	32.686	0.000	0.717	4	0.179	26.474	0.000

The effect of the tested insecticides application rate on the dry weight of new leaves and old of treated tomato was carried out by drying 10 g of the fresh leaves of each replicate with each treatment. The results of Methomyl treatments in table (3) showed that, at the recommended rate of 35 g and 15 g/100L water, a non-significant effect on the dry weight of new leaves was recorded. But at the highest rate of application the reduction in dry weight was highly significant as compared to other treatment and control. However, in the case of old leaves , despite the effect of application rate on the dray weight was significant between the treatments and control, but the reduction in the weigh was small and the variation between treatment was not significant with exception of the highest rate of application at 70 g/100L . Those results reflected that, Methomyl at rate higher than the recommended are phytotoxic to local (Hassawi) tomato plant and exhibited more phytotoxic effect on shoots and new leaves in the tomato plant.

Table (3). The effective of Methomyl treatments on the new shots and leaves of Tomato expressed as main of dry weight, with five replications per treatment per each type of leaves

Treatment g/100 L	New shot Dry weight	New leaves* Dry weight	Old leaves* Dry weight
	Mean ± SD	Mean ± SD	Mean ± SD
Control	0.0766 ± 0.0198 ab	2.6080 ± 0.0737 a	1.6696 ± 0.0738 a
15	0.0870 ± 0.0377 a+	2.6078 ± 0.1426 a	1.3905 ± 0.0617 bc
35	0.0509 ± 0.0069 bc	2.5338 ± 0.1697 a	1.4075 ± 0.0485 b
50	0.0517 ± 0.0130 bc	1.7686 ± 0.5728 b	1.3499 ± 0.0416 bc
70	0.0252 ± 0.0074 c	1.9432 ± 0.3392 b	1.3350 ± 0.0315 c

- *10 g of New and old leave were dried and weighted
- Means not followed by a common letter are significantly different, (+) indicates to positive effect of treatment as determined by Duncan LSD alpha (P = 0.05)

The effect of Imidacloprid application rate on the dry weight of new leaves and old leaves of treated tomato represented in the table (4). The results showed a non-significant different between the lowest rate and control, even though the rate of 25 g/100L, showed a slightly positive stimulation to the growth of new leaf, but this wasn't significant as compared to the control. The reduction in the dry weight of new leave were significant with the three highest application rates, but the highest significant reduction in the dry weight was reported at 150 g/100L, and the mean of dry weight at this rate treatment was lower than any other treatment and control. In other hands the effects of those treatment on dry weight of old leaves table (4) showed that, despite the significant differences between the treatment but the reduction in weight in correlation to application rates were small. This findings are match with the previous study of (Ebel et al 2000) reported the total of dry leaves and shoot was decreased linearly across the Imidacloprid treatment.

Table (4). The effective of Imidacloprid treatments on the new shots and leaves of Tomato expressed as main of dry weight, with five replications per treatment per each type of leaves

Treatment g/100 L	New shot Dry weight	New leaves* Dry weight	Old leaves* Dry weight
	Mean ± SD	Mean ± SD	Mean ± SD
Control	0.0766±0.0198 a	2.6080 ± 0.0737 a	1.6696 ± 0.0738 a
25	0.0848 ± 0.0182 a+	2.7224 ± 0.3533 a+	1.4965 ± 0.0944 b
50	0.0408 ± 0.0097 b	1.9598 ± 0.4283 b	1.3763 ± 0.1057 c
100	0.0342 ± 0.0098 b	1.6302 ± 0.2604 bc	1.2878 ± 0.0609 cd
150	0.0240 ± 0.0089 b	1.4760 ± 0.2546 c	1,1804 ± 0.0678 d

- *10 g of New and old leave were dried and weighted
- Means not followed by a common letter are significantly different, (+) indicates
- to positive effect of treatment as determined by Duncan LSD alpha (P = 0.05)

The results In table (5) showed that, Phytotoxic symptoms developed on Methomyl treatment of the highest rate of 70 g after 3 days of application. Whereas at the recommended rate of 35 g and 50 g, the phytotoxic symptoms developed after 12 and 9 days of treatment respectvily. However, in case of imdacloprid the lowest application rate of 25g represented a positive influences on the chlorosis of leaf, where the chlorophyll chlorosis measured by SPAD was significantly higher than control. The symptoms at the highest rate was developed after 3 days, but with rest of higher treatments the phytotoxicity developed within second week of treatment and this results was similar to what reported by (Ebel et al 2000). This results was confirmed with total mean of all Imdacloprid and Methomyl treatments which showed significant reduction in chlorosis at LSD of mean at (5% level). Analysis of regression of leaf chlorosis with time (day) In both experiments of imidacloprid and Methomyl treatments, reflected the linear decreasing in Leaf chlorosis across treatments, at coefficient rate (-0.308, R^2 = 98%) and (-0.294, R^2 = 85%) respectively. It is appear that, both insecticides cause reduction in clorosis of chlorophyll and the phytotoxicity was directly correlated to the application rate, as the symptoms increased as the application rate was increased.

Table (5). The effect of time after treatments on leaf Chlorosis of chlorophyll

Day	Methomyl				
	control	15 g	35 g	50 g	70 g
1	42.28	43.14	43.12	43.12	43.28
3	44.18	44.88	41.54	42.26	37.64*
6	42.92	42.36	41.36	41.12	37.26*
9	42.92	43.36	40.74	38.88*	35.56*
12	46.08	40.46*	40.16*	37.72*	34.58*
15	45.42	43.04	38.22*	35.40*	34.98*
Grand mean	43.94 a	42.87 a	40.86 b	39.75 b	37.22 c
Day	Imidacloprid				
	control	25 g	50 g	100 g	150 g
1	42.28	48.76**	42.66	45.58	42.08
3	44.18	43.56	41.94	42.2	38.26*
6	42.92	46.78**	41.88	40.58	36.98*
9	42.92	47.50**	37.82*	37.62*	33.78*
12	46.08	47.66	38.36*	36.02*	32.78*
15	45.42	46.02	34.32*	35.06*	31.20*
Grand mean	43.94 b	46.71 a	39.83 c	39.51 c	35.88 d

Analysis of covariance (two-way ANOVA) in randomized blocks of the interaction between the treatment and day on the chlorophyll, the mean followed by (*) indicated the decreasing in chlorophyll chlorosis and (**) indicate the improvement of chlorosis are significantly different at LSD of mean at (5% level). The grand Means not followed by a common letter are significantly different, at (P = 0.05).

The effect phytotoxic symptoms of leaf marginal necrosis, and reduced shoot growth on the mineral content was studied to exhibit the influence of increasing in the application rate of foliar treatment on the nutrient content in the leaves of treated plant (Table 6). However in case of Methomyl treatment, the only significant influence was recorded as quadratic relationship with the content of K, which was decreased with the two lowest application rate (the recommended of 35g and below it of 15g/100L water), and increased again with the highest application rate of 50 and 70g/ 100L water. whereas Zn, Cu, Ca, Mg, P and N showed no significant increase or decrease linearly or quadratically across Methomyl application rates .

The experiment of Imidacloprid showed no significant influences of foliar application on the nutrient content in the treated leaves. None of the analyzed elements table (6) were varied quadratically or linearly with the changing in the application rate, except the N which was varied quadraticaly at the highest rate of application. It is clear that the foliar treatments of Methomyl or imidacloprid did not altered plant nutrition, except the highest rate of imidacloprid which cause significant reduction in the nitrogen content at the highest rate in the treated leaves. However, Ebel et. al. (2000) reported the influence increasing the application of Imidacloprid on the nutrient contents in the leaves of cucumber treated. their differences with our results could be due to the difference in the application methods, since they used the soil treatment, but in our experiment the foliar treatment was applied. In addition the half live of imidacloprid in tomato is 3 days (Romeh, et. al. 2009). Whereas the half-life in soil is considerably greater than in plant, Al-Sayeda, (2007) found, when 0.33 mg of imidacloprid added to the soil of pot planted with tomato, that 2.3, 5 and 7% of the insecticide was absorbed by plant after 30, 40 and 75 days of the treatment and more than 85% of the insecticide was transferred and located in the leaves and from 8 to 15% was found in the roots. Mullins, (1993) reported the half-life of imidacloprid in soil is up to 150 days. It appears that excess of imidacloprid in plant form long exposure period of the soil treatment disrupts metabolism sufficiently to cause senescence and alteration in the nutrient content of the old treated leaves. But the excess of the insecticides as results of foliar application cause senescence, because that imidacloprid is directly catabolized by the plant. Thus, differences in plant nutrition are likely a result of influence of insecticide application and not a cause of the phytotoxicity symptoms.

Table (6). Effect of Methomyl and Imidacloprid spray application on nutrient content of Tomato leaves 15 d after treatment.

Treatment g/100 L water	Zn (ppm)	K (ppm)	Cu (ppm)	Ca (ppm)	Mg (ppm)	P (ppm)	N % (mg·g^{-1} dry wt)
Control	40	980	13.1	32.5	24.22	0.243	6.031243
Methomyl							
M 15g	39	902	13.7	30.5	23.5	0.255	6.819449
M 35g	38	922	13.4	34.6	23.9	0.243	7.156851
M 50g	39	980.5	12.8	28.5	23.3	0.258	6.811049
M 70g	41	988.2	13.7	30.3	23.8	0.237	6.251246
Intercept	S**	S**	S**	S**	S**	S**	S**
L	NS	NS	NS	NS	NS	NS	NS
Q	NS	S*	NS	NS	NS	NS	NS
Imidacloprid							
Im 25g	38.5	948.5	13.9	30.103	23.5	0.21	6.458246
Im 50g	41	948.6	13.7	28.9	23.9	0.255	7.00005
Im 100g	40	952.2	13.5	29.5	23.02	0.243	6.700448
Im 150g	40.2	952.6	13.7	29.3	23.5	0.201	4.597633
Intercept	S**	S**	S**	S**	S**	S**	S**
L	NS	NS	NS	NS	NS	NS	NS
Q	NS	NS	NS	NS	NS	NS	S*

Linear relationships (L) indicate that plant response increased or decreased in a straight line across methomyl or imidacloprid treatments, significant quadratic relationships (Q) indicate that plant response increased to some maximum and then decreased again, or decreased to some minimum and then increased again. NS, S*, S** mean Nonsignificant or significant at P= 0.05 or 0.0001 respectively.

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التأثيرات السميّة للمبيدات الجهازية Imidacloprid و Methomyl على نبات الطماطم ونوعية الثمار بعد الحصاد في الزراعات المحمية

محمد جمال تيسير حجار، محمد سالم الصيخان، أحمد محمد محمد سليمان

جامعة الملك فيصل-كلية العلوم الزراعية و الاغذية- الاحساء- السعودية

يعتبر المبيدان ايميداكلوبريد وميثوميل من المبيدات الحشرية الجهازية الشائعة الاستخدام وعلى نطاق واسع لمكافحة الحشرات التي تصيب المحاصيل في الزراعات المحمية وفي الزراعات المفتوحة في محافظة الإحساء في المملكة العربية السعودية. هذه المبيدات المستخدمة لابد أن يكون لكثرة استخدامها وزيادة معدلات الاستخدام أثار جانبية سلبية على المحصول المزروع والمعامل، ناهيك عن تأثيراتها السلبية على صحة البيئة والإنسان. لذلك أجريت هذه الدراسة على صنف الطماطم المحلي والشائع زراعته في الإحساء لدراسة التأثرات السمية والضارة لهذه المبيدات بالتراكيز الموصي بها وبالتراكيز العالية على النباتات المرشوشة. تم اختبار المبيد ايميداكلوبريد بالمعدل الموصى به (٥٠ غ/ ١٠٠ لتر ماء) وبالمعدلات التالية أيضا (٢٥، ١٠٠ و 150 غ/ ١٠٠لتر)، ومبيد الميثوميل بالمعدل الموصى به (٣٥ غ/ ١٠٠ لتر ماء) وبالمعدلات التالية (١٥، ٥٠ ، ٧٠ و ١٠٠ غ/ ١٠٠لتر). بينت النتائج أن كلا المبيدين كان لهما تأثرات سمية نباتية تمثلت الأعراض بتبرقش الأوراق القديمة وتشوه في النمو ونخر هامشي في الأوراق الفتية والحديثة النمو. وسجلت هذه الأعراض بعد د ٣ أيام من تطبيق المعدل الأعلى للاستخدام مع كلا من المبيدين المختبرين، لكن مع بقية معدلات الاستخدام باستثناء المعدل الموصي وأدنى منه فقد ظهرت الأعراض خلال الأسبوع الثاني من التطبيق.

تأثر حجم النموات الحديثة معنويا بزيادة معدلات الاستخدام لكل من ايميداكلوبريد وميثوميل، وقد انعكس ذلك في انخفاض الوزن الجاف للنموات الحديثة مقارنة مع الشاهد غير المعامل. أما في حالة الأوراق القديمة، فعلى الرغم من الاختلافات المعنوية بين المعاملات وبالمعدلات المختلفة إلا أن الانخفاض في الوزن الجاف مع ارتفاع معدلات الاستخدام المختبرة كان صغيرا. أظهرت معدلات الاستخدام الدنيا (١٥ و٢٥ غ/١٠٠لتر) والتي هي أدنى من المعدلات الموصى بها وعلى حد سواء للمبيدين المختبرين على التتابع، تحفيزا إيجابي في النموات الجديدة التي ظهرت بعد العلاج، على الرغم من أن أدنى معدل (٢٥ غ/لتر) من ايميداكلوبريد ظهرت معه بعض أعراض السمية النباتية بنهاية التجربة. وبينت نتائج الدراسة أن السمية النباتية للمبيد ايميداكلوبريد كانت

أعلى وأشد من تأثير مبيد الميثوميل على نبات الطماطم. وكان التأثير السمي لمعدلات الاستخدام العالية على النبات أعلى بكثير من معدلات الاستخدام الدنيا للمبيدات المختبرة.

أظهرت الدراسة أن المعاملات برش المجموع الخضري للنبات وزيادة معدلات الاستخدام عن المنصوح بها لكل من مبيد ميثوميل و ايميداكلوبريد لم تؤثر على تغذية النباتات حيث لم يلاحظ في التحليل الإحصائي الخطي والتربيعي المتعدد الحدود أي تغير معنوي لكمية العناصر المعدنية الغذائية الأساسية (Zn, Cu, Ca, Mg, P ,K, N) في الأوراق المعاملة وحتى بالتراكيز العالية مقارنة مع الشاهد، باستثناء أعلى معدل من ايميداكلوبريد (١٠٠ غ/١٠٠لتر) حيث أظهر التحليل التربيعي المتعدد الحدود فرقا معنويا في المحتوى النيتروجين للأوراق المعاملة. إن زيادة معدلات الاستخدام للمبيدين المختبرين رشا على المجموع الخضري سببت الشيخوخة بالأوراق المعاملة ولم تسبب تغير معنوي في محتوى العناصر المغذية في أوراق النبات المعالجة، نظرا لأن المبيدات الحشرية المرشوشة على النبات تستقلب مباشرة في النبات. وهكذا، فإن الاختلافات في المحتوى من العناصر المعدنية في النباتات المعاملة من المحتمل ان يكون نتيجة لتأثير تطبيق مبيدات الحشرات وليس سببا بسب ظهور أعراض السمية النباتية على الأوراق المعاملة .