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Heavy metal accumulations after two years of some organic fertilizers and girdling on apple fruit

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Abstract

This investigation was carried out during growing season of 2015-16 on five years old apple tree cv. Xank grown in the orchard at Gavarky, Duhok governorate, Kurdistan region-Iraq. To study the effect of two girdling date (before full bloom and after fruit set), compost application at levels (0, 3 and 5 kg.tree⁻¹) and sheep manure application at three levels (0, 4 and 6 kg.tree⁻¹), on heavy metals accumulation in fruit of apple fruits. According to obtained results, it noticed that girdling (date 2) gave the higher level of Cd, Cu, pb, Zn at season 2015 (0.082, 2.30, 0.78 and 27.74 mg.kg⁻¹) and season 2016 (0.82, 1.62, 0.31 and 9.19 mg.kg⁻¹) respectively, and Compost specially at 5kg.Tree⁻¹ has significantly increased Cd, Cu, pb, Zn at season 2015 (0.076, 2.37, 0.38 and 36.22 mg.kg⁻¹) while, at 2016 (0.073, 1.47, 0.35 and 10.86 mg.kg⁻¹). Sheep manure specially at 6 kg.tree⁻¹ significantly increased the Cd, pb, Cu, Zn at season (0.072, 2.34, 0.83 and 36.1 mg.kg⁻¹). So at season 2016 (0.069, 1.67, 0.33 and 13.34 mg.kg⁻¹). while, the interactions between girdling, compost and sheep manure significantly affected most studied parameters at girdling date two + 5 kg.Tree⁻¹ of compost plus 6kg.tree⁻¹ of sheep manure increased Cd, pb, Cu, Zn at season 2015 (0.121, 2.45, 0.41 and 38.00 mg.kg⁻¹) however, at season 2016 (0.119, 2.24, 0.40 and 14.43 mg.kg⁻¹) significantly.

Keywords: Girdling, sheep manure, compost, heavy metal, apple fruit

1. Introduction

The Apple (*Malus domestica* Borkh) is perennial tree belonged to Rosaceae family, its popular to be consumed due to their convenience and durability. There are more than 2000 varieties of apple grow in temperate climate zones and in a wide range of soil types. The compost has an important role in the agriculture sector because it contain a high amount of elements necessary for plant growth and soil improvement, the use of compost as a fertilizer for plant in Iraq and Kurdistan has a large space and this is backward in the field of agriculture when we compare with the progressive countries (Azad and Nawzad, 2015) [3]. Recently researchers have started to give attention positive effect of organic manure application more than of chemical fertilization for environment and on human beings healthy as sheep manure and compost (Zuoping, *et al.*, 2014) [11] indicated that the application of organic manure at 25-30 t.ha⁻¹ with chemical fertilizer on “Fuji” apple trees caused an increase in fruit quality, and total yield. Pinamonti, *et al.*, (1997) [17] studied the effect of cattle manure, SB compost (from sewage sludge and poplar barks) and MSW compost in 14 different of *Malus domestica* orchards. The results clearly shown that using compost (MSW) about six-year period causes increasing the concentration of Zn, Pb and Cd in the soil and also the Pb and Cd then these metals will transform to the fruits. The aim of study was to investigate the effect of organic manures and girdling on flowering and yield characteristics of apple tree fruits after two years of application to improve flower buds induction and yields. AL-Kahtani and Ahmed, (2012) [12] investigate the effect of different mixtures of organic fertilizers on olive trees composted agriculture waste (1 Date palm: 1 olives: 1 maize) + 10 % sheep manure resulted in decreasing heavy metals concentration (Pb, Ni, Co and Cd). Thus, I was encouraged to use the compost as a first study in Kurdistan and Iraq in order to encourage our farmer to use the compost as a plant fertilizer. The risks and problems posed by heavy metals in fertilizers and other soil inputs have increasingly drawn the attention of farmers, environmental organizations, consumers, and public policymakers. This study examines a wide spectrum of soil amendments and fertilizers used in organic agriculture, including biosolids, major nutrient fertilizers, industrial wastes, composts, liming materials and micronutrient sources with a focus on inputs used in organic agricultural production in Kurdistan-Iraq (Azad and Nawzad 2015) [3].

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Weibel, *et al.*, (2013)^[10] studied that applying compost from green wastes to two-year old ‘Topaz’ apple trees at (8000 kg.ha⁻¹, y⁻¹) cause to improve the fruit weight, fruit quality, total yield, and mineral content in the fruits. Van Schoor, *et al.*, (2010)^[3] investigate the application of compost as organic manure to the pear fruit trees, it causes to improve fruit quality and other reproductive characteristic. Moreover, it noticed that about two year after application the total yield significantly increased. Girdling is usually carried out by cutting through the phloem and removing a strip of tissue from the bark of tree. When no strip of tissue is removed, the process is seems to as scoring. The main function of girdling is to reduce the transfer of carbohydrates to lower parts of the tree and to the roots. In this way, carbohydrates were accumulated above the girdling area. According to (Minh, *et al.*, 2012)^[6] the girdling of Wax apple that done before flowering about three weeks, lead to reduce bud drop, and fruit drop. They found that girdling lead to enhance fruit parameters (fruit length, fruit diameter, fruit set, fruit weight, and total soluble solid).

This investigation aimed to study the responsible of Xank cultivars to local environmental condition, and their responsibility to fertilized by organic matter (compost and sheep manure). However, it also hopes to confirm the risk of heavy metal concentration in compost, sheep manure, since there are little or no studies in Kurdistan about the role of organic fertilization in yield and quality of Apple, for this reason the aims to study interaction effect of Compost,

Sheep manure, Girdling and their interactions on nutrient statutes and some heavy metal concentrations of Apple fruit after two years applications.

2. Materials and Methods

This study was carried out on private orchard of six years old of Xank apple trees, located in Gavarky, center of Duhok city during season 2015-16. To investigate the effect of girdling date, sheep manure and compost after two years of application on heavy metal accumulation in fruits of cv. Xank. Girdling was done by removing the bark of three main branches of each tree carefully about 5 – 6 mm in two times (date 1) before flowering on 9/3/2015 and (date 2) after fruit set on 19/4/2015 by knife. The application of compost and sheep manure was done in January 26th 2015, (Table 1, 2) by a working hole around the tree under the projection of brunches at three levels (0, 3, and 5 kg.tree⁻¹), (0, 4, and 6 kg.tree⁻¹), respectively. The compost that was used in this experiment consisted from residues waste of Duhok city, produced in Kawashi factory of compost fertilizer. The experiment was consisted of 18 treatments with three replications; with individual tree for each experimental unit. The total number of trees used was 54 trees and using Randomize Complete Block Design (RCBD) as factorial experiment. Moreover, the data were analyzed statistically by using (SAS, 1996)^[8]. Soil analysis was carried out at Agricultural Research Center in Duhok (Table 2-3).

Table 1: Some parameters of compost produced in factory of Duhok city tested by Eggersmann Company (2014).

Parameters	Lab test results	EU end of waste compost standard	Recommendation for Kurdistan standard in year			
Dry matter	87.4 %					
Moisture content	12.6 %					
Organic matter	54.4 %					
Salt content	8.77 g KCl/l					
pH-value	7.3					
Total N	1.54 %					
Total P (P ₂ O ₅)	0.54 %					
Total P (K ₂ O)	0.80 %					
Heavy metals (mg.kg⁻¹)				2014	2018	2022
Cadmium (Cd)		3.74	1.5	4.0	2.5	1.5
Lead (Pb)		252	120	160	140	120
Zinc (Zn)		562	600	600	600	600

Table 2: Some parameters of sheep manure tested in faculty of agriculture Duhok University at (2015).

Parameters	Sheep manure analysis
Total N %	6.83
K %	1.03
P %	5.36
Fe mg.kg ⁻¹	0.354
Zn mg.kg ⁻¹	0.031
Heavy metals (mg.kg⁻¹)	
Pb	0.646
Cd	0.035

Table 3: Some physical and chemical properties of the orchard soil analysis on laboratory of soil and water department, faculty of Agriculture, University of Duhok.

Properties	Results	Properties	Results
Moisture continent %	2.57	Zn mg.kg ⁻¹	0.058
pH	7.64	Fe mg.kg ⁻¹	0.195
E C ds.m ⁻¹	0.37	Pb mg.kg ⁻¹	0.354
CEC cmol.kg ⁻¹	25.18	Cd mg.kg ⁻¹	0.053
Clay%	32.95		
Silt %	42.02		
Sand %	24.97		
Texture %	Silty Clay		

2.1 Measurements

2.1.1 Fruit nutrients and heavy metals concentration

After taking fruit dry weight, 0.5 gm of dried samples were taken for digestion using a mixture of concentrated H₂SO₄ with H₂O₂ (10ml) and (5ml) respectively (Stylianidis *et al.*, 2004) [9]. Then nutrient and heavy metals were determined by using atomic absorption (Mehmet, 2010) [5] (Ge'rrard *et al.*, 2000) [4].

1. Cadmium (mg.kg⁻¹)
2. Copper (mg.kg⁻¹)
3. Lead (mg.kg⁻¹)
4. Zinc (mg.kg⁻¹)

3. Results and Discussion

3.1 Fruit cadmium concentration (mg.kg⁻¹)

Table (4) indicates that the concentration of cadmium in fruit at both seasons that in girdle (date 2) (0.086 and 0.083 mg.kg⁻¹) was more than of girdle (date 1) (0.024 and 0.022 mg.kg⁻¹). It was noticed that the sheep manure application to the Xank apple trees has visible effect in the concentration

of cadmium in fruits especially at (6 kg.tree⁻¹) gave the highest value at both seasons (0.072 and 0.069 mg.kg⁻¹) compared with control. The compost application at (5kg.tree⁻¹) resulted in higher cadmium concentration in fruit at both seasons that was (0.076 and 0.073 mg.kg⁻¹) compared with control. The results in table (1) display that the interactions between girdling (date 2) with 6 kg.tree⁻¹ sheep manure gave the maximum cadmium concentration in fruit at both seasons (0.101 and 0.099 mg.kg⁻¹). The results show that the treatment of girdling (date 2) + 6 kg.tree⁻¹ compost give higher cadmium conc. (0.107 and 0.105 mg.kg⁻¹) at both seasons. The interactions effect of sheep manure application at 6 kg.tree⁻¹ with compost application at 5 kg.tree⁻¹ obtained highest cadmium concentration in fruit at both seasons (0.108 and 0.106 mg.kg⁻¹). The interactions among girdling (date 2) + 6 kg.tree⁻¹ sheep manure + 5 kg.tree⁻¹ compost give the highest Cd conc. in fruit at both seasons (0.121 and 0.119 mg.kg⁻¹). Nevertheless, the lowest value obtained from control of girdling (date 1) which was (0.010 and 0.008 mg.kg⁻¹).

Table 4: Effect of girdling date, sheep manure, compost and their interactions on fruit cadmium (mg.kg⁻¹) concentration of apple tree cv. Xank at both season 2015 -16.

Girdling date	Sheep Manure (kg.tree ⁻¹)	Season 2015				Season 2016					
		Compost (kg.tree ⁻¹)			GD * Sh	Girdling	Compost (kg.tree ⁻¹)			GD * Sh	Girdling
		0	3	5			0	3	5		
D1	0	0.010 f	0.014 ef	0.019 e	0.015 e	0.024b	0.008 i	0.012 f-i	0.017 fg	0.012 e	0.022 b
	4	0.013 ef	0.017 e	0.018 e	0.016 e		0.012 h-g	0.015 f-h	0.016 fg	0.014 e	
	6	0.013 ef	0.019 e	0.095 c	0.042 d		0.011 hi	0.017 f	0.092 d	0.040 d	
D 2	0	0.018 e	0.071 d	0.094 c	0.061 c	0.086a	0.008 i	0.070 e	0.092 d	0.057 c	0.082 a
	4	0.077 d	0.101 b	0.107 b	0.095 b		0.068 e	0.099 c	0.105 b	0.091 b	
	6	0.075 d	0.106 b	0.121 a	0.101 a		0.073 e	0.104 bc	0.119 a	0.099 a	
Compost		0.034c	0.054b	0.076a			0.03 c	0.053 b	0.073 a		
GD * C	D 1	0.012 f	0.017 e	0.044 d			0.008 f	0.015 e	0.041 d		Sheep manure
	D 2	0.057 c	0.093 b	0.107 a			0.052 c	0.091 b	0.105 a		
Sh * C	0	0.014 e	0.043 d	0.057 c	0.038c		0.008 e	0.041 d	0.054 c	0.034 c	
	4	0.045 d	0.059 bc	0.063 b	0.057b		0.040 d	0.057 bc	0.061 b	0.053 b	
	6	0.044 d	0.063 b	0.108 a	0.072a		0.042 d	0.061 b	0.106 a	0.069 a	

The same letters in means of each interaction was not significantly different from each other according to duncan's multiple ranges test at 5% level.

3.2 Fruit Copper concentration (mg.kg⁻¹)

It is obvious in table (5) that girdling (date 2) has significant increase in the conc. of copper at both seasons (2.30 and 1.62 mg.kg⁻¹) in fruit. The results fairly display that the soil application of Compost has a significant increase in the copper concentration in fruits at both seasons especially at 5 kg.tree⁻¹ that was (2.37 and 1.47 mg.kg⁻¹). The results fairly display that the soil application of sheep manure has a significant increase in the copper concentration in fruits at both seasons especially at 6 kg.tree⁻¹ that was (2.34 and 1.67 mg.kg⁻¹). The interactions between girdling (date 2) with 6 kg.tree⁻¹ sheep manure gave the maximum copper conc. in fruit at both seasons was (2.36 and 1.92 mg.kg⁻¹). About the

interactions effect of girdling date and compost application on copper concentration in fruits, the results show that the girdling date (2) with 5 kg.tree⁻¹ gave maximum value at both seasons (2.38 and 2.31mg.kg⁻¹) in fruit. There was a significant effect between (sheep manure and compost) application on the fruit copper concentration especially at (6 kg.tree⁻¹ + 5 kg.tree⁻¹), which gave the highest value at both seasons (2.44 and 2.44mg.kg⁻¹) compared with all other interaction treatments. Regarding the triple interaction among girdling date (2) + 6 kg.tree⁻¹ sheep manure + 5 kg.tree⁻¹ compost resulted in higher copper conc. at both seasons (2.45 and 2.24 mg.kg⁻¹) in fruits as compared with all other treatment combinations.

Table 5: Effect of girdling date, sheep manure, compost and their interactions on the fruit copper (mg.kg⁻¹) concentration of apple tree cv. Xank at both season 2015 -16

Girdling date	Sheep Manure (kg.tree ⁻¹)	Season 2015				Season 2016					
		Compost (kg.tree ⁻¹)			GD * Sh	Girdling	Compost (kg.tree ⁻¹)			GD * Sh	Girdling
		0	3	5			0	3	5		
D1	0	2.12 i	2.22 gh	2.37 bc	2.24 d	2.29b	0.14 i	1.03 g	1.14 ef	0.77 f	1.14 b
	4	2.25	2.28 ef	2.31 de	2.28 c		0.88 h	1.14 ef	1.67 d	1.23 e	
	6	2.36 b-d	2.27 ef	2.44 a	2.36 a		1.08 fg	1.16 e	2.03 b	1.42 c	
D 2	0	2.18 h	2.26 e-g	2.32 cd	2.25 cd	2.30a	0.14 i	1.66 d	2.04 b	1.28 d	1.62 a
	4	2.39 b	2.27 e-g	2.37 bc	2.34 ab		1.02 g	1.89 c	2.04 b	1.653 b	
	6	2.26 e-g	2.26 e-g	2.45 a	2.32 b		1.02 g	1.89 c	2.24 a	1.72 a	
Compost		2.26b	2.26b	2.37a			0.03 c	0.72 b	1.47 a		Sheep manure

GD * C	D 1	2.24 c	2.26 bc	2.37 a		0.70 e	1.11 d	1.62 c	
	D 2	2.28 b	2.26 bc	2.38 a	Sheep manure	0.73 f	1.82 b	2.31 a	
Sh * C	0	2.15 e	2.24 d	2.35 b	2.25c	0.14 h	1.35 e	1.59 c	1.03 c
	4	2.32 bc	2.27 d	2.34 bc	2.31b	0.95 g	1.52 d	1.86 b	1.44 b
	6	2.31 c	2.27 d	2.44 a	2.34a	1.05 f	1.53 d	2.44 a	1.67 a

The same letters in means of each interaction was not significantly different from each other according to duncan's multiple ranges test at 5% level.

3.3 Fruit lead concentration (mg.kg⁻¹)

Table (6) shows that the lead concentration in fruit at both seasons is higher (0.78 and 0.31 mg.kg⁻¹) with girdling (date 2). Application of sheep manure at both levels had significant increase in the concentration of lead at both seasons in fruit (0.83 and 0.33 mg.kg⁻¹) compared with control. The compost application at 5 kg.tree⁻¹ caused increase at both seasons in the concentration of lead in fruit (0.38 and 0.35 mg.kg⁻¹). The interaction between girdling (date 2) and 6 kg.tree⁻¹ sheep manure gave the highest lead concentration at both seasons in fruit (0.36 and 0.35 mg.kg⁻¹) compared with all other interactions. Manifest the interactions between girdling (date 2) + 5 kg.tree⁻¹ compost

make maximum value at both seasons (0.39 and 0.37 mg.kg⁻¹) as compared with other combinations. The combination between sheep manure and compost application has significant effect at both seasons in the concentration of lead in fruit, the treatment of sheep manure at 6 kg.tree⁻¹ + 5 kg.tree⁻¹ compost which record (0.39 and 0.371 mg.kg⁻¹) Compared with control. The result of interactions treatment of girdling (date 2) + 6 kg.tree⁻¹ sheep manure + 5 kg.tree⁻¹ compost gave great significant differences at both seasons in the concentration of lead in fruit the value documented (0.41 and 0.40 mg.kg⁻¹), as compared with all other treatment combinations.

Table 6: Effect of girdling date, sheep manure, compost and their interactions on fruit lead (mg.kg⁻¹) concentration of apple tree cv. Xank at both season 2015 -16.

Season 2015						Season 2016					
Girdling date	Sheep Manure (kg.tree ⁻¹)	Compost (kg.tree ⁻¹)			GD * Sh	Girdling	Compost (kg.tree ⁻¹)			GD * Sh	Girdling
		0	3	5			0	3	5		
D1	0	0.14 h	0.30 f	0.33 e	0.25 e	0.31b	0.11 j	0.28 h	0.31 d	0.23 e	0.29 b
	4	0.32 e	0.36 d	0.38 b	0.35 b		0.30 g	0.33 e	0.36 b	0.33 b	
	6	0.32 e	0.32 e	0.36 cd	0.34 c		0.30 g	0.30 g	0.34 d	0.32 c	
D 2	0	0.22 g	0.32 e	0.37 bc	0.30 d	0.78a	0.11 i	0.30 g	0.35 c	0.25d	0.31 a
	4	0.33 e	0.36 cd	0.37 bc	0.35 b		0.31 f	0.33 e	0.35 c	0.33 b	
	6	0.33 e	0.35 d	0.41 a	0.36 a		0.31 f	0.33 e	0.40 a	0.35 a	
Compost		0.28c	0.34b	0.38a			0.24 c	0.31 b	0.35 a		
GD * C	D 1	0.26 f	0.33 d	0.36 b			0.24 f	0.31 d	0.34 b		Sheep manure
	D 2	0.29 e	0.34 c	0.39 a	Sheep manure	0.24 e	0.32 c	0.37 a			
Sh * C	0	0.16 g	0.31 f	0.35 c	0.61b		0.11 h	0.29 g	0.33 d		0.24 b
	4	0.33 e	0.36 c	0.38 b	0.84a		0.31 f	0.33 c	0.36 b		0.33 a
	6	0.33 e	0.34 d	0.39 a	0.83a		0.31 f	0.32 e	0.37 a		0.33 a

The same letters in means of each interaction was not significantly different from each other according to Duncan's multiple ranges test at 5% level.

3.4 Fruit zinc concentration (mg.kg⁻¹)

Table (7) shows that the zinc concentration at both seasons in fruits (27.74 and 9.19 mg.kg⁻¹) of girdle tree (date 1). Obviously, the sheep manure application has significant influence at both seasons in increasing the concentration of zinc in fruit at (6 kg.tree⁻¹) sheep manure (36.17 and 13.34 mg.kg⁻¹) compared with control. The compost application at 5 kg.tree⁻¹ resulted in higher significant increase at both seasons in the zinc concentration in fruit (36.22 and 10.86 mg.kg⁻¹) compared with control. The data in table (4) illustrates that the interactions between girdling date and sheep manure application have significant influence at both seasons in the concentration of zinc in fruit, the highest value obtained from girdling (date1) with (6 kg.tree⁻¹) which was (35.78 and 14.98 mg.kg⁻¹), compared with other

interaction treatments. Regarding the interactions effect of girdling (date 2) with compost application at (5 kg.tree⁻¹) was the surpass treatment at both seasons in increasing the zinc concentration in fruit (38.33 and 11.611 mg.kg⁻¹) compared with other treatment. The results in the same table, illustrate that the interactions between sheep manure application at (6 kg.tree⁻¹) plus compost application at (5 kg.tree⁻¹) obtained highest zinc concentration at both seasons in fruit which was (47.67 and 14.22 mg.kg⁻¹) as compared with control. In respect with the interactions effect of the three studied factors the interactions treatment of girdling (date 1) + 6 kg.tree⁻¹ sheep manure + 0 kg.tree⁻¹ compost gave the highest value at both seasons was (38.00 and 14.43 mg.kg⁻¹), as compared with all other treatment combinations.

Table 7: Effect of girdling date, sheep manure, compost and their interactions on fruit zinc (mg.kg⁻¹) concentration of apple tree cv. Xank at both season 2015 -16.

Season 2015						Season 2016					
Girdling date	Sheep Manure (kg.tree ⁻¹)	Compost (kg.tree ⁻¹)			GD * Sh	Girdling	Compost (kg.tree ⁻¹)			GD * Sh	Girdling
		0	3	5			0	3	5		
D1	0	18.00 h	24.00 f	30.67 d	24.22 d	27.44b	3.27 j	5.40 i	5.27 i	4.64 f	9.14 b
	4	21.33 g	26.67 de	31.00 b	26.33 c		7.53 gh	11.83 cd	11.07 cd	10.14 de	
	6	28.00 d	32.00 c	35.33 ab	31.78 b		11.00 cd	12.93 c	14.00 b	12.64 a	
D 2	0	18.00 h	24.33 ef	26.67 de	23.00 d	27.74a	3.27 j	10.20 de	11.20 cd	8.22 d	9.19a

	4	26.33 h	27.00 d	27.67 d	27.00 cd		6.53 hi	7.20 gh	9.20 ef	7.64 e	
	6	28.00 d	33.67 bc	38.00 a	33.22 a		8.53 fg	12.17 c	14.43a	11.71 b	
	Compost		21.94c	27.95b	36.22a		7.92 c	10.29 b	10.86 a		
GD * C	D 1	22.44 d	27.56 c	38.33 a		Sheep manure	8.93 d	10.72 b	10.11 bc		Sheep manure
	D 2	21.44 d	28.33 c	34.11 b			6.11e	9.86	11.61 a		
Sh * C	0	18.00 h	24.17 f	29.67 cd	23.95c		3.27 f	7.80de	8.23 d	6.43 c	
	4	19.83 g	26.83 e	31.33 bc	26.00b		7.03 e	9.52 c	10.13 c	8.89 b	
	6	28.00 de	32.83 b	47.67 a	36.17a		12.27 b	13.55 a	14.22 a	13.34 a	

The same letters in means of each interaction was not significantly different from each other according to Duncan's multiple ranges test at 5% level.

4. Discussion

The effect of compost and sheep manure on the leaf heavy metal accumulations may be due to the improvement of soil physical, biological properties and chemical properties resulting more release of nutrient elements available which absorbed by plant root and its effect on the physiological process, such as the photosynthesis activity as well as the utilization of carbohydrates, in addition to water use efficiency, also adequate nutrient quantities of nitrogen, phosphorus, and potassium, which increase both rate of leaf expansion as well as cell division which subsequently leads to larger individual leaves and higher photosynthesis activities (Abd El-Wahab, 2011) ^[1]. May be attributed to a higher nutritional uptake mainly by greater expansion of root system due to increased supply of photosynthetic productions in the leaves, attributed to presence of plant growth regulators (Azad and Nawzad, 2015) ^[3].

5. Conclusions

1. The girdling date two was superior on the girdling date one in increasing in most fruit heavy metals accumulations measured.
2. Soil application of compost at a level 6kg.Tree⁻¹ was more than other levels and control in increasing most fruit heavy metal accumulation.
3. Sheep manure applications at level 5kg.tree⁻¹ had more effects on the increasing of most fruit heavy metal states.
4. The interaction of girdling date two + 6Kg of compost + 4 girdling date kg.tree⁻¹ had more effect on increasing in most studied parameters.

6. Recommendations

Depending on the conclusions mentioned previously, the following points of view can be recommended:

1. Testing the other tree fruit may lead to better results.
2. Testing the different level and time application of compost may lead obtain preferable results, also testing other organic fertilizer such as animal manure chicken manure and municipal can obtain better results.
3. Our recommend the farmers to use the compost in their orchards like other organic fertilizer, such as animal manure without any fear of toxic materials, soil pollution and harmful effect of heavy metals.
4. Our recommend the Kawashi manufacture of compost in Duhok city to produce good compost, clean and free from any harmful material, reduces added the toxic materials like expired medicine and car trees and Battery since all of these materials lead to increase the heavy metal concentrations.

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