

INFLUENCE OF ORGANIC MANURES AND GIRDLING DATES ON HEAVY METAL ACCUMULATIONS OF APPLE FRUIT AFTER TWO SEASONS OF APPLICATION

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ABSTRACT

This investigation was carried out during season of 2014-2015 on five years old apple tree (*Malus domestica Borkh*) 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 5kg.tree⁻¹) and sheep manure application at three levels (0, 4 and 6kg.tree⁻¹), on heavy metals accumulation of apple fruits after two years of application. According to obtained results, it noticed that girdling (date 2) was best time for girdling, gave the higher level of Cd, Cu, pb, (0.082, 1.619 and 0.311 mg.L⁻¹) respectively, and Compost specially at (5)kg.tree⁻¹ has significantly increased fruit heavy metal content Cd, Cu, pb, Zn (0.073, 1.963, 0.352 and 10.861mg.L⁻¹). Sheep manure specially at (6)kg.tree⁻¹ significantly increased the fruit nutrients content Cd, pb, Cu, Zn (0.069, 1.674, 0.332 and 13.344mg.L⁻¹), while, the interactions between girdling, compost and sheep manure significantly affected most of the studied parameters and the more effective treatment interactions was girdling (D2 + 5kg.Tree⁻¹ of compost plus 6kg.Tree⁻¹ of sheep) manure significantly increased Cd, pb, Cu, (0.119, 2.843 and 0.401 mg.L⁻¹) respectively.

KEYWORD: Girdling, Sheep manure, Compost, heavy metal, Apple fruit

INTRODUCTION

The Apple (*Malus domestica* Borkh) is perennial tree belonged to Rosaceae family, its popular to be consumed due to their convenience and durability. It has arisen in the Caucasus region of southeastern Europe (Watkins *et al.*, 2013). There are more than 2000 varieties of apple grow in temperate climate zones and in a wide range of soil types (Azad, 2007).

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 Kurdistan and Iraq has a large space and this is backward in the field of agriculture when we compare with the progressive countries (Azad and Nawzad, 2015) (Azad and Hasan, 2016). 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 (Janick, 2007. (Pinamonti, *et al.*, 1997) studied the effect of cattle manure; **SB** compost from (Sewage sludge and poplar Barks) and **MSW**

(Municipal Solid Waste) 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 Pinamonti *et al.*, (2007). (AL-Kahtani and Soliman, 2012) 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 Iraq (Azad and Nawzad 2015).

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 (Davie *et al.*, 1995). According to (Minh, *et al.*, 2012) 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.

This investigation aimed to study the effect of compost, sheep manure, girdling and their interactions on some heavy metals concentration in apple fruit after two seasons applications. The risk of heavy metal concentration in apple fruits by compost or sheep manure fertilization program, and relationship on human health, since there are little or no studies in Kurdistan about the role of organic fertilization in yield and quality of apple fruits.

MATERIALS AND METHODS

This study was carried out on private orchard of six years old of local cv.Xank apple trees,

located in Gavarky, center of Duhok city during season 2014-2015. 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 (D1) before flowering on 9/3/2014 and date (D2) after fruit set on 19/4/2014 by knife. The application of compost and sheep manure was done in January 26th 2014, (Table 2 and 3) 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 Kowashi factory of compost fertilizer. The experiment was consisted of 18 treatments with three replications ; with individual tree for each experimental unit, using Randomize Complete Block Design (RCBD) as factorial experiment (Al-Rawi and Khalaf-Alla, 2000). Moreover, the data were analyzed statistically by using (SAS, 2000). Soil, compost and sheep manure analysis was carried out at Faculty of Agricultural Research Center in Duhok (Table 1, 3), Eggersmann Company (Table 2).

Table (1): Some physical and chemical properties of the orchard soil

Properties	Results	Properties	Results
Moisture content %	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		

The soil analysis carried out in the soil laboratory, soil and water department, College of Agriculture, University of Duhok.

Table (2): 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 KCl/l	8.77 g		

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 (3): Some parameters of sheep manure tested in College of Agriculture Duhok University at (2014).

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

MEASUREMENTS:

Heavy metals nutrient concentration of fruit:

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). Then heavy metals were determined by using atomic absorption (Mehmet, 2010).

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

RESULTS AND DISCUSSIONS

1-Cadmium concentrations of fruit (mg.kg⁻¹)

The table (4) indicates that the concentration of cadmium in fruit that in girdle (D2) (0.083mg.kg⁻¹) was more than of girdle (D1) (0.022mg.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 (0.069mg.kg⁻¹) compared with control (0.034mg.kg⁻¹). The compost application at (5kg.tree⁻¹) resulted in

higher cadmium concentrations in fruit that was (0.073mg.kg⁻¹) compared with control (0.03mg.kg⁻¹). The results in table (4) display that the interactions among girdling (D2) + 6kg.tree⁻¹ sheep manure + 5kg.tree⁻¹ compost give the highest (Cd) conc. in fruit (0.119mg.kg⁻¹). Nevertheless, the lowest value obtained from control of three factors which was (0.008mg.kg⁻¹).

2- Copper concentrations of fruit (mg.kg⁻¹)

It is obvious in table (5) that girdling (D2) has significant increase in the conc. of copper (1.619mg.kg⁻¹) in fruit than (1.144mg.kg⁻¹) those on trees of girdling (D1). The results fairly display that the soil application of sheep manure has a significant increase in the copper concentration in fruits especially at 6kg.tree⁻¹ that was (1.674mg.kg⁻¹). Moreover, the lowest value obtained with control (1.028mg.kg⁻¹). Regarding the triple interactions among girdling date (D2) + 6 kg.tree⁻¹ sheep manure + 5 kg.tree⁻¹ compost resulted in higher copper conc. (2.843 mg.kg⁻¹) in fruits as compared with all other treatment combinations.

3- Lead concentrations of fruit (mg.kg⁻¹)

Table (6) shows that the lead concentration in fruit is higher (0.311 mg.kg⁻¹) with girdling (D2) than (0.293mg.kg⁻¹) from girdling (D1). Application of sheep manure at both levels had significant increase in the concentration of lead in fruit (0.332mg.kg⁻¹) compared with (0.242mg.kg⁻¹) from control. The compost application at 5kg.tree⁻¹ caused increase in the concentration of lead in fruit (0.352 mg.kg⁻¹) compared with control (0.240mg.kg⁻¹).

Table (4): Effect of girdling date, sheep manure, compost and their interactions on fruit cadmium (mg.kg^{-1}) concentrations of apple tree cv. Xank at season 2015.

Girdling date	Sheep Manure (kg.tree^{-1})	Compost (kg.tree^{-1})			GD * Sh	Girdling
		0	3	5		
D1	0	0.008 i	0.012 f-i	0.017 fg	0.012 e	0.022 b
	4	0.012 h-g	0.015 f-h	0.016 fg	0.014 e	
	6	0.011 hi	0.017 f	0.092 d	0.040 d	
D 2	0	0.008 i	0.070 e	0.092 d	0.057 c	0.082 a
	4	0.068 e	0.099 c	0.105 b	0.091 b	
	6	0.073 e	0.104 bc	0.119 a	0.099 a	
Compost		0.03 c	0.053 b	0.073 a	Sheep manure	
D * C	D1	0.008 f	0.015 e	0.041 d		
	D2	0.052 c	0.091 b	0.105 a		
Sh * C	0	0.008 e	0.041 d	0.054 c	0.034 c	
	4	0.040 d	0.057 bc	0.061 b	0.053 b	
	6	0.042 d	0.061 b	0.106 a	0.069 a	

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

Table (5): Effect of girdling date, sheep manure, compost and their interactions on fruit copper (mg.kg^{-1}) concentrations of apple tree cv. Xank at season 2015.

Girdling date	Sheep Manure (kg.tree^{-1})	Compost (kg.tree^{-1})			GD * Sh	Girdling
		0	3	5		
D1	0	0.143 i	1.037 g	1.143 ef	0.774 f	1.144 b
	4	0.880 h	1.140 ef	1.670 d	1.230 e	
	6	1.083 fg	1.160 e	2.037 b	1.427 c	
D 2	0	0.143 i	1.663 d	2.040 b	1.282 d	1.619 a
	4	1.020 g	1.893 c	2.047 b	1.653 b	
	6	1.023 g	1.897 c	2.843 a	1.921 a	
Compost		0.715 c	1.465 b	1.963 a	Sheep manure	
GD * C	D 1	0.702 e	1.112 d	1.617 c		
	D 2	0.729 f	1.818 b	2.310 a		
Sh * C	0	0.143 h	1.350 e	1.592 c	1.028 c	
	4	0.950 g	1.517 d	1.858 b	1.442 b	
	6	1.053 f	1.528 d	2.440 a	1.674 a	

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

The result of interactions treatment of girdling (D2) + 6 kg.tree^{-1} sheep manure + 5 kg.tree^{-1} compost gave great significant differences in the

concentration of lead in fruit the value documented (0.401 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}) concentrations of apple tree cv. Xank at season 2015.

Girdling date	Sheep Manure (kg.tree^{-1})	Compost (kg.tree^{-1})			GD * Sh	Girdling
		0	3	5		
D1	0	0.106 j	0.282 h	0.305 d	0.231 e	0.293 b
	4	0.302 g	0.332 e	0.361 b	0.332 b	
	6	0.304 g	0.304 g	0.341 d	0.316 c	
D 2	0	0.106 i	0.301 g	0.351 c	0.253d	0.311 a
	4	0.313 f	0.334 e	0.352 c	0.333 b	
	6	0.311 f	0.330 e	0.401 a	0.347 a	
Compost		0.240 c	0.314 b	0.352 a	Sheep manure	
GD * C	D 1	0.237 f	0.306 d	0.336 b		
	D 2	0.243 e	0.322 c	0.368 a		
Sh * C	0	0.106 h	0.292 g	0.328 d	0.242 b	
	4	0.307 f	0.333 c	0.357 b	0.332 a	
	6	0.308 f	0.317 e	0.371 a	0.332 a	

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

4-Zinc concentration of fruit (mg.kg^{-1})

The table (7) shows that the zinc concentration in fruits (9.922mg.kg^{-1}) of girdle tree (D1) was more than (9.193mg.kg^{-1}) from girdling (D2). Obviously, the sheep manure application has significant influence in increasing the concentration of zinc in fruit at (6kg.tree^{-1}) resulted in higher significant increase in the zinc

concentration in fruit manure (13.344mg.kg^{-1}) compared with control (6.433mg.kg^{-1}). The data in table (7) illustrates that the interactions effect of the three studied factors the interaction treatment of girdling (D1) + 6kg.tree^{-1} sheep manure + 0kg.tree^{-1} compost gave the highest value that was (16.000mg.kg^{-1}), as compared with all other treatment combinations.

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

Table (7): Effect of girdling date, sheep manure, compost and their interactions on fruit zinc (mg.kg^{-1}) concentrations of apple tree cv. Xank at season 2015.

Girdling date	Sheep Manure (kg.tree^{-1})	Compost (kg.tree^{-1})			GD * Sh	Girdling
		0	3	5		
D1	0	3.267 j	5.400 i	5.267 i	4.644 f	9.922 a
	4	7.533 gh	11.833 c	11.067 cd	10.144 c	
	6	16.000 a	14.933 ab	14.000 b	14.978 a	
D 2	0	3.267 j	10.200 de	11.200 cd	8.2222 d	9.193b
	4	6.533 hi	7.200 gh	9.200 ef	7.644 e	
	6	8.533 fg	12.167 c	14.433 b	11.711 b	
Compost		7.917 c	10.289 b	10.861 a	Sheep manure	
GD * C	D 1	8.933 d	10.722 b	10.111 bc		
	D 2	6.111e	9.856	11.611 a		
Sh * C	0	3.267 f	7.800 de	8.233 d	6.433 c	
	4	7.033 e	9.517 c	10.133 c	8.894 b	
	6	12.267 b	13.550 a	14.217 a	13.344 a	

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; Azad and Nawzad, 2015). 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 (Ge´rard *et.al.*, 2000 and Arancon *et.al.*, 2004).

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پوخته

ئەف قەكولينه يا هاتيه كرن لسالا ۲۰۱۴-۲۰۱۵ لسهر دارا سيف خانكئ يا پينج سالي لناف بيستانئ گه قهركئ ل بازيرئ دهوكئ-ههريما كوردستانئ بو زانينا كارتيكرنا دوو وهختيت تيفل راكرنا تاكا پشتي بدوماهيك هاتنا كويليكي, كومپوست بسئ ئاستا (۳ و ۵) كگم/دار ئو زبلئ پهزي بسئ ئاستا (۴ و ۶) كگم/دار لسهر هه بونا توخميت گران لناف به رهه مئ سيقا پشتي دوو سالا.

لديف ئەنجاميت بدهست من كه فتين وهختي دووي ز تيفل كرنئ ريژا توخميت گران

(0.082) (Zn, Pb, Cu, Cd) و ۱,۶۱۹ و ۱,۳۱۱ و ۹,۹۲۲ و ۰,۳۱۱ ملگرام/لتر) لديف ئيك.

ههروهسا كومپوست بخهستيا ۵ كگم بشيوهكي پشووهري ئەف توخمه زيده كرن بفي رهنگي (Zn, Pb, Cu, Cd) (0.073) (۱,۹۶۳ و ۱,۳۵۲ و ۱۰,۸۶۱ و ۰,۳۵۲ ملگرام/لتر). ههروهسا زبلئ پهزي (۵ كگم/دار) هه مان توخم (Zn, Pb, Cu, Cd) زيده كرن بفي رهنگي (۰,۰۶۸ و ۰,۶۷۴ و ۱,۳۳۴ و ۰,۳۴۴ ملگرام/لتر). ههروهسا كارتيكرنا سيياني (تيفل راكرن و كومپوست لگه ل زبلئ پهزي) لسهر هه بونا قان توخما لناف به رهه مئ سيقئ دا ديار بو وهختي دووي يئ تيفل راكنئ دگه ل ۵ كگرام كومپوست ئو ۶ كگرام زبل/دار بو ئەگهري زيده كرن قان توخما (Zn, Pb, Cu, Cd) بفي رهنگي (۰,۱۱۹ و ۲,۸۴۳ و ۴,۰۱۰ و ۱۶,۰۰۰ ملگرام/لتر) لديف ئيك.