The Effect of Organic Manure and Potassium Fertilizers on Growth, Yield and Fruit Quality of Anna Apple Trees

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ABSTRACT

The present study was carried out at a private orchard at El-Akrisha Kafr El-Dawar district, Behera Governorate, Egypt, on eight years old "Anna" apple trees (*Malus domestica*, Bork) buded on Balady rootstock during the 2008/2009 and 2009/2010 growing seasons under surface irrigation system. This investigation aimed to study the response of Anna apple trees to organic amendment type (cattle (M1) and horse (M2) manures) with rate of 25 kg/tree/year (20 m^3/fed/year), with two different types of potassium fertilizers (K_2SO_4 (SOP) & KCl (MOP) with three levels from each type (0,50 and 100kg K_2O /fed/year). The results indicated that horse manure (M2) was more effective than cattle manure in improving the measured parameters (number of leaves/shoot, leaf area, number of flowers/ cluster, fruit set%, fruit weight, fruit length, fruit diameter as well as yield, anthocyanine %, starch%, TSS%, average fruit firmness (lb/$inch^2$), total sugars%, acidity% and leaf NPK content). The data clarified that increasing the rate of potassium significantly increased all tested parameters for the two types of potassium fertilizers compared with control (zeroK_2O). On the other hand, potassium chloride gave the best results to improve the studied characters compared with potassium sulfate. The results also indicated that the best treatment was when fertilizing Anna apple trees with horse or cattle manure with rate 20 m^3/fed/year and applying 100 kg K2O (K_2SO_4 or KCl). The yield of these treatments reached 21 and 17 ton/fed for horse and cattle manure, respectively compared with control (11 ton/year).

Key words: Apple trees, fertilizer, organic manure and potassium.

INTRODUCTION

Apple (*Malus domestica*, Bork.) is considered as one of the most important fruit crops grown in the world. Apple fruits are highly appreciated by Egyptian consumers and considered as a good source of energy and vitamin A and C.

The Egyptian soils are cultivated twice and in some areas 3 times per year with high crop yields which remove continuously large amounts of potassium from soils without replenishing the removal of K by crops. This show that soil fertility, which is one of the important natural resources requires fertilizers to combat the worldwide degradation of fertile soils (Abd El-Hadi,1989 and Abd El-Hadi *et al*., 1990). Potassium (K) is very important in the plant photosynthesis process and helping plants metabolize their food to get energy, potassium is involved in many aspects of plant physiology (Marschner, 1995), activates more than enzyme systems, aids in photosynthesis, promotes water uptake, regulates nutrients translocation in plant, favours carbohydrate transport and storage, enhances nitrogen uptake and protein synthesis and increases yield. El-Morshedy 1997 and Attala 1997, reported that potassium fertilization increased weight, fruit TSS and total sugars of apple fruits. Potassium plays an important role in the transport of assimilates and nutrients, mainly sucrose and amino acids must be transported from the leaves to the site of their use or storage in fruits, roots, tubers, seeds, and grains (Mengel, 1997). The amount of potassium required to obtain a significant improvement in fruit size and/ or color of apples in similar to that recommended for soil application; 50 kg or more per acre (Hanson, 1996).

Animal manure contains varying levels of nutrients and organic matter. The disadvantage of adding manure to orchards is that the nitrogen is released over a prolonged period of time. This slow release means that perennial crop continues to receive nitrogen throughout the year, resulting in poor fruit color, excessive terminal growth and delayed hardening of the woody tisse. Organic matter contains varying levels of nutrients which improve fruit quality, increase total nitrogen and increase significantly soil available N, P, and K (Montassser, 1987, Mahmoud 1994 and Badran *et al*., 2000, Saleh *et al*., 2006 and Soliman *et al*., 2006).

The aim objective of this study is to examine the effect of potassium fertilizers (type and rate) and animal manure on vegetative growth, yield , and fruit quality of Anna apple trees.

MATERIALS AND METHODS

The present study was carried out during two successive seasons of 2008/2009and 2009/2010 in a private orchard at El-Akrisha, Kafr El-Dawar district, Behera Governorate, Egypt on "Anna" apple trees (*Malus domestica*, Bork.) ,8 years old, buded on Balady rootstock and spaced at 4 meters apart. The soil of the orchard is clay type, under surface irrigation system, soil samples were randomly taken from two depths (0-50cm

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and 50-100cm).Main chemical and physical soil characters were made according to Page (1982) are shown in Tables (1and 2). The chemical properties of cattle and horse manures are shown in Table (3).

The analysis of soil and manures were carried out according to the methods described by Page (1982). Healthy apple trees nearly uniform as possible in growth vigor and productivity were chosen for this investigation. The trees were subjected under flooding irrigation system.

This experiment included twelve treatments as follows:

1-(20 m^3 cattle manure +zero potassium sulfate)/fed/year.

2-(20 m^3 cattle manure/ +50Kg K2O potassium sulfate)/fed/year.

3-(20 m^3 cattle manure +100Kg K2O potassium sulfate)/fed/year.

4-(20 m^3 cattle manure +zero potassium chloride)/fed/year.

5-(20 m^3 cattle manure +50Kg K2O potassium chloride)/fed/year.

6-(20 m^3 cattle manure +100Kg K2O potassium chloride)/fed/year.

7-(20 m^3 horse manure +zero potassium sulfate)/fed /year.

8-(20 m^3 horse manure +50KgK2O potassium sulfate)/fed/year.

9-(20 m^3 horse manure +100Kg K2O(potassium sulfate)/fed/year.

10-(20 m^3 horse manure +zero potassium chloride)/fed /year.

11-(20 m^3 horse manure +50KgK2O potassium chloride)/fed/year.

12-(20 m^3 horse manure +100Kg K2O potassium chloride)/fed/year.

Twelve fertilization treatments were arranged in a split- split plot design and each treatment was replicated four times and each replicate consisted of 4 trees according to Snedecor and Cochran (1990). Cattle and horse manures were added to surface soil followed by tillage at the end of December. Potassium fertilizers

Table 1. Soil chemical properties of the field experiment

Season	Depth cm	pH	EC	OM%	Soluble cations me/L				Soluble anions me/L				NPK mg kg-1		
					Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	$_{2-}^{SO4}$	N	P	K
2008/2009	0-50	8.26	4.22	1.85	10.3	7.6	20.1	4.2	0.0	8.3	17.4	16.5	600	8.0	220
	50-100	7.67	1.15	0.35	3.3	1.4	6.6	0.7	0.0	2.4	3.4	5.7	200	4.6	97
2009/2010	0-50	8.32	4.37	1.79	12.4	8.3	18.6	4.4	0.0	10.2	14.6	18.9	700	9.2	235
	50-100	7.80	1.46	0.48	3.7	1.2	8.7	1.0	0.0	3.1	5.4	6.1	300	4.2	113

* pH in soil suspension (1:2.5)

** EC, anions, and cations (soil paste extract)

*** Available P extracted by $NaHCO_3$,and available K extracted by Amm.acetate.

Table 2. Particle size distribution and calcium carbonate content

Season	Depth cm	CaCO3 %	Particle size distribution %			Texture
			Clay	Silt	Sand	
2008/2009	0-50	10.23	48.04	30.26	21.70	Clay
	50-100	8.45	36.91	39.74	23.35	Clay Loam
2009/2010	0-50	9.86	47.90	31.26	20.84	Clay
	50-100	8.21	38.71	35.73	25.56	Clay Loam

Table 3. Chemical properties of cattle and horse manure

Components	Cattle Manure		Horse Manure	
	2008/2009	2009/2010	2008/2009	2009/2010
pH	8.4	8.1	8.5	8.6
EC, ds/cm	12.12	13.20	14.05	15.17
O.M %	21.04	22.27	28.17	31.32
Total N %	0.83	0.78	1.23	1.18
C:N ratio	12.4	12.8	11.3	11.4
Total P %	0.26	0.31	0.35	0.33
Total K %	0.61	0.64	0.86	0.74
Moisture %	25.27	24.59	21.66	20.21

were added at the end of January in both seasons. Phosphorus fertilizer (1kg super phosphate /tree/year) was added with organic manure. Nitrogen fertilizer (2kg ammonium nitrate) was added in 4 equal doses, the first was on March, 1, the second 20 days after first, the third 15 days after the second,the fourth after harvest.

Measured parameters:

- Number of flowers/cluster and fruit set were determined on selected branches1.5″ diameter according to Agnello *et al*. (1999).
- The percentage of flowers set was assessed on the same branches by counting the remaining fruits in late May when the fruit drop was finished.
- Fruits were harvested in late June in both seasons. All fruits on each tree were counted; weighed and average fruit (weight, length and diameter) were estimated.
- Fruit firmness was recorded two sides of each fruit using EPT-1 pressure tester fitted with an 11.1 mm (0.43inch).

To determine anthocyanine pigment, one gm of the apple peel tissues was removed from by spaced location at the equatorial region of each fruit sample, net anthocyanine was extracted by ethanolic HCl (which consisted of 98ml ethanol 95% + 2 ml concentrated HCl). Extraction was carried out for 24 hours at 2°C with 50 ml of the prepared solution. Petrolium ether (150 ml) was added to pigment extraction of each sample, filtrated and completed to a final volume of 100 ml with ethanol. The optical densities of the filtrates were measured by a Carle Zeiss Photo Electric Colorimeter at 530 n.m. Anthocyanine was expressed as O.D/g of fresh weight (mg/100gm fresh weight) according to Rabino *et al*. (1977).

The percentage of total soluble solids in the juice of each fruit was determined by a hand refractometer, fruit acidity percentage (expressed as malic acid) ,total sugar percent and starch percent were determined according to A.O.A.C.(2000).

For leaf mineral analysis, twenty five leaves on each experimental trees were collected from mid portion of current season shoots. Leaf samples were washed by several times with tap water and distilled water to remove any spray residues and other deposits. The leaf samples were then dried to a constant weight in paper bag a drying oven at 70-80°C. Leaf sample were ground by stainless steel rotary knife, the ground samples were redried to a constant weight. From the ground dried material of each sample, 0.3gm was digested with sulphoric acid and hydrogen peroxide according to (FAO, 1980). N, P and K concentrations were determined using semi-automatic nitrogen distillation unit, Spectrophotometer 21D and Jenway Flame Photometer, respectively according to the methods described by Westerman, (1990).

Statistical analysis:

The obtained data were analyzed using the CoHort Software (1986) statistical package. Average values from the four replicates of each treatment were interpreted using the analysis of variance (ANOVA). The Duncan's Test was used for comparison between means as advised by Steel and Torrie (1980).

RESULTS AND DISCUSSION

1- Vegetative growth:

Data presented in Table (4) show main, sub main and interaction effects of the three tested factors including (cattle and horse manures) with three levels of K_2SO_4 and KCl with concentrated of 0, 50 and 100 Kg of K_2O.

1.1. Main and submain effect

The highest results recorded in this regard were (25.50 and 23.11) for number of leaves/ shoot for horse and cattle manure and (38.94 and 37.94) for leaf area for horse and cattle manure during first season and the same trend was found in the second season. Increasing K level, also, increase these parameters. These results are in harmony with Awad and El-Shenawi (2005) they found that organic manure caused increased in vegetative growth on Williams banana variety.

1.2. Interaction effect

The increasing of K rate with horse manure showed a significant increase in number of leaves and leaf area with ($20m^3$ horse manure + 100 kg K_2O (in form of KCl)/ fed/ year than other treatments during two seasons. Land application of organic manure increases soil organic matter and improves the soil properties and this effect will be reflected on increasing vegetative growth. These results are in agreement with those of El-Shenawi (2000), El-Kouny *et al*. (2004), Fayed (2005) and Eman *et al*. (2010).

2- Flowers and fruit set

Data presented in Table (5) declared that main and interaction effects of the three tested factors in the field experiment on Anna apple under clay soil conditions. The obtained data showed that there were significant effects due to the treatments on the Anna apple trees concerning number of flowers/cluster and fruit set % during the two growing seasons.

Table 4. The effect of animals manure and potassium fertilizers on number of leaves/shoot and leaf area of Anna apple trees

Treatments			Number of leaves/ shoot		Leaf area (cm^2)	
			2008/2009	2009/2010	2008/2009	2009/2010
Cattle manure	K_2SO_4	0	21.00	19.00	36.70	37.00
		50	22.30	23.00	38.00	38.00
		100	25.30	26.70	39.00	41.00
	KCl	0	21.10	19.20	36.50	37.20
		50	22.00	25.30	38.00	39.70
		100	27.00	28.00	39.70	41.00
Horse manure	K_2SO_4	0	22.30	19.70	36.70	38.00
		50	26.00	26.00	39.00	39.00
		100	26.70	29.00	41.00	42.00
	KCl	0	22.50	20.00	36.80	38.20
		50	26.70	28.00	39.70	41.00
		100	29.00	31.30	41.30	44.00
L.S.D. 0.05			1.681	1.738	1.766	1.827
Manures	**Cattle**		23.11	23.50	37.94	39.05
	Horse		25.50	25.61	38.94	40.44
L.S.D 5%			**1.26**	**1.45**	**0.71**	**0.63**
K-Type	**K_2SO_4**		23.94	23.88	38.33	39.27
	KCl		24.66	25.22	38.55	40.22
L.S.D 5%			**0.61**	**1.12**	**0.55**	**0.41**
K-Levels	**Zero K**		12.66	19.33	36.50	37.50
	50 K_2O		24.25	25.58	38.66	39.50
	100K_2O		27.00	28.25	40.16	42.25
L.S.D 5%			**0.84**	**1.09**	**0.88**	**1.14**

Table 5. The effect of animals manure and potassium fertilizers on number of flowers / cluster and fruit set of Anna apple trees

Treatments			Number flowers/ cluster		Fruit set (%)	
			2008/2009	2009/2010	2008/2009	2009/2010
Cattle manure	K_2SO_4	0	9.10	10.70	13.00	15.00
		50	11.00	12.00	14.70	19.70
		100	11.70	14.00	16.70	23.00
	KCl	0	9.00	10.60	13.20	15.20
		50	10.00	13.70	15.30	19.30
		100	12.00	15.00	17.30	23.70
Horse manure	K_2SO_4	0	10.70	11.00	13.30	18.00
		50	11.70	12.70	16.00	21.00
		100	13.00	16.00	17.30	25.00
	KCl	0	10.80	11.20	13.40	18.10
		50	11.00	13.70	16.00	23.00
		100	13.70	17.70	18.30	27.00
L.S.D. 0.05			**1.553**	**1.225**	**1.206**	**1.328**
Manures	**Cattle**		10.44	12.50	14.94	19.55
	Horse		11.61	13.27	15.83	21.88
L.S.D 5%			**1.09**	**0.63**	**0.47**	**1.24**
K-Type	**K_2SO_4**		11.00	12.50	15.16	20.44
	KCl		11.05	13.27	15.61	21.00
L.S.D 5%			**0.57**	**1.23**	**0.48**	**0.67**
K-Levels	**Zero K**		9.66	10.58	13.33	17.00
	50 K_2O		10.83	12.92	15.50	20.75
	100K_2O		12.58	15.17	17.33	24.42
L.S.D 5%			**0.77**	**0.728**	**0.60**	**1.15**

2.1. Main and sub main effect

The highest results in Table (5) were recorded (11.61 and 10.44 average of the first season) for horse and cattle manures for number of flowers/ cluster and (15.83 and 14.94)for fruit set %, respectively. Increasing K levels, also, increase these parameters. The data gave the same trend in the second season.

2.2. Interaction effect

Data in Table (5) declared that application of organic manure and potassium fertilization (20 m^3 horse manure + 100 kg K_2O (in form of KCl/ fed /year) to apple trees caused significant increase in number of flowers/cluster and fruit set % and gave the best results in both seasons of study (Stiles and Reid 1991and Abou El-Khashab *et al*., 2005).

Organic manure contains all the essential micro and macro elements required for plant growth .Land application of organic manure increases soil organic matter and improves soil organic matter and improves a number of soil properties including texture, water-holding capacity, oxygen content and soil fertility .It also increases water infiltration rates, reduces nutrient leaching and increases crop yields (Cassman *et al*. 1995). Gething (1986) reported that potassium performs many functions in plant metabolism , promoting photosynthesis, conserving water, speeding up the transport of the products of metabolism between different parts of plant .At all levels in plants, within individual cells, tissues and in long distance transport via the xylem and phloem, K exists as a free ion in solution or as an electrostatically bound cation .Potassium takes part in many essential processes: enzyme activation, protein synthesis, photosynthesis, phloem transport, osmoregulation, cation-anion balance, stomatal movement and light-driven mastic movements (Marschner, 1995). These results are in accordance with that obtained by Stiles and Reid (1991).

3- Fruit characters

Data presented in Table (6) show main, sub main and interaction effects of the three tested factors including (cattle and horse manures) with three levels of K_2SO_4 and KCl with levels of 0, 50 and 100 Kg of K_2O. The results indicated that there were significant effects due to the treatments on the apple trees fruit characters including (fruit weight, length and diameter) during the two seasons.

3.1. Main and sub main effect

In Table (6) the average of horse and cattle manure were (139.66 and 135.77) for fruit weight (gm) in first season; (13.06 and 12.367) for fruit length (cm) and 3.883 and 6.783) for fruit diameter (cm), respectively. Increasing K levels, increase the studied parameters. Similar trend was obtained in the second season.

3.2. Interaction effect

The results presented in Table (6) indicated that application of organic manure and potassium chloride fertilizer [20m^3 horse + 100 Kg K_2O (in form of KCl)/ fed/ year] to apple trees increased (fruit weight, length and diameter) significantly in the two seasons compared with control. The obtained data are in accordance with that obtained by Neilsen *et al*. (2004). They found that organic manure and potassium increased fruit (weight, length and diameter) in apple fruits.

4- Yield characters

Data presented in Table(7) illustrate main and interaction effects of the three tested factors including organic amendments type, potassium type and potassium fertilizers level. The results showed that their were significant effects due to the treatments on the Anna apples trees yield characters including yield (Kg)/ tree and yield (ton)/ fed during the two growing seasons.

4.1. Main and sub main effect

The data presented in Table(7) showed that the values ranged between (41.88 and 38.88) in first season for horse and cattle manures for yield (Kg)/ tree and (13.90 and 13.20) for yield (ton)/ fed, respectively. Results were nearly similar in the second season. Increasing K levels increased the studied parameters. Results are in line with El-Kouny *et al*. (2004)and Naik and SrihiHari Babu (2007).

4.2. Interaction effect

Combined effects of cattle and horse manure type of potassium mineral and level of mineral potassium fertilizer to apple trees on the yield characters were presented in Table (7). It is clear that most interactions were statistically significant, which indicate a high degree of interdependence between the studied factors. This was apparent with all considered yield parameters. The most pronounced increase in yield Kg/tree and yield (ton/fed) were obtained for combination of horse or cattle manure with high rate of potassium chloride in both growing seasons. These results are in harmony with Awad and El-Shenawi (2005) and El-Shenawi and El-Sayed (2005). They reported that organic manure and potassium increase yield in banana plants.

5- Fruit quality 1

Data presented in Table (8) illustrated main, sub main and interaction effects of the three tested factors in the trial on Anna apple fruit quality under the same conditions. The obtained results showed that there were significant effects due to the treatments on the Anna

Table 6. The effect of animals manure and potassium fertilizers on fruit weight, fruit length and fruit diameter of Anna apple trees

Treatments			Fruit weight (gm)		Fruit length (cm)		Fruit diameter (cm)	
			2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010
Cattle manure	K_2SO_4	0	122	121	11.73	11.83	6.27	6.00
		50	136	140	12.10	12.37	6.40	6.43
		100	147	145	12.57	12.73	6.70	6.63
	KCl	0	125	122	11.83	11.90	6.31	6.20
		50	140	143	12.67	12.93	6.90	7.00
		100	147	150	13.43	13.87	7.10	7.50
Horse manure	K_2SO_4	0	125	124	11.97	12.03	6.63	6.17
		50	138	140	12.70	13.27	6.73	6.77
		100	149	146	13.40	13.53	6.80	7.00
	KCl	0	127	125	11.88	11.95	6.10	11.88
		50	148	149	13.77	13.9	7.33	13.77
		100	154	156	14.53	14.9	7.77	14.53
L.S.D. 0.05			**6.41**	**7.66**	**0.03**	**0.03**	**0.70**	**0.03**
Manures	Cattle		135.77	13.38	12.37	12.59	6.78	6.56
	Horse		139.66	139.55	13.06	13.24	6.88	6.86
L.S.D 5%			**6.36**	**4.38**	**0.20**	**0.27**	**1.01**	**0.43**
K-Type	K_2SO_4		135.64	135.72	12.41	12.63	6.59	6.48
	KCl		139.50	140.22	13.02	13.21	7.08	6.94
L.S.D 5%			**1.632**	**3.279**	**0.06**	**0.106**	**0.45**	**0.15**
K-Levels	Zero K		123.50	122.16	11.84	11.93	6.45	6.03
	50 K2O		140.58	142.75	12.82	13.12	7.02	6.82
	100K2O		149.08	149.00	13.48	13.71	7.03	7.22
L.S.D 5%			**3.21**	**3.83**	**0.11**	**0.14**	**0.41**	**0.20**

Table 7. The effect of animals manure and potassium fertilizers on yield kg/tree and yield ton/fed of Anna apple trees

Treatments			Yield (kg)/tree		Yield (ton)/ fed	
			2008/2009	2009/2010	2008/2009	2009/2010
Cattle manure	K_2SO_4	0	30.00	32.30	10.20	10.95
		50	36.70	37.70	12.48	12.70
		100	45.30	51.30	15.40	17.45
	KCl	0	31.10	33.00	10.30	11.00
		50	41.30	43.00	14.05	14.60
		100	49.00	52.00	16.65	17.68
Horse manure	K_2SO_4	0	33.70	37.00	11.45	12.58
		50	37.00	41.00	12.58	13.95
		100	48.00	62.30	16.30	21.00
	KCl	0	33.50	37.40	11.50	12.70
		50	42.30	50.00	14.38	17.00
		100	56.70	62.70	19.28	21.40
L.S.D. 0.05			**3.29**	**3.11**	**3.16**	**2.75**
Manures	Cattle		38.88	41.44	13.20	14.10
	Horse		41.88	48.33	13.90	16.40
L.S.D 5%			**2.89**	**2.28**	**2.29**	**0.36**
K-Type	K_2SO_4		38.63	43.61	13.00	14.80
	KCl		42.61	46.16	14.00	15.70
L.S.D 5%			**1.49**	**1.72**	**1.37**	**0.30**
K-Levels	Zero K		31.83	34.66	10.80	11.75
	50 K_2O		39.58	42.91	13.35	14.60
	100K_2O		49.75	57.08	16.45	19.40
L.S.D 5%			**1.64**	**1.56**	**1.17**	**0.52**

Table 8. The effect of animals manure and potassium fertilizers on anthocyanine, starch and total soluble solids of Anna apple fruits

Treatments			Anthocyanine (mg/100gm)		Starch (%)		Total soluble solids (%)	
			2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010
Cattle manure	K_2SO_4	0	16.1	15.7	3.1	3.2	9.33	9.67
		50	16.8	16.3	3.3	3.5	9.67	10.00
		100	17.6	17.2	3.5	3.7	10.00	11.33
	KCl	0	16.2	15.8	3.0	3.3	9.43	9.85
		50	17.3	17.3	3.5	3.8	11.00	11.59
		100	18.0	17.8	3.6	4.1	11.67	12.57
Horse manure	K_2SO_4	0	16.4	15.9	3.1	3.4	9.67	9.33
		50	17.2	17.2	3.4	3.7	10.67	11.00
		100	17.8	17.7	3.6	4.1	11.68	11.33
	KCl	0	16.5	16.0	3.1	3.3	9.72	9.42
		50	17.5	17.7	3.4	4.0	11.00	11.34
		100	18.3	18.5	3.7	4.3	12.00	13.00
L.S.D. 0.05			**0.343**	**0.31**	**0.19**	**0.22**	**1.219**	**1.41**
Manures	Cattle		16.97	16.68	3.36	3.59	10.333	11.11
	Horse		17.26	17.05	3.38	3.80	10.972	10.83
L.S.D 5%			**0.33**	**0.38**	**0.19**	**0.19**	**0.119**	**0.238**
K-Type	K_2SO_4		16.97	16.62	3.33	3.61	10.333	11.82
	KCl		17.26	17.11	3.41	3.79	10.972	11.28
L.S.D 5%			**0.11**	**0.26**	**0.11**	**0.10**	**0.385**	**0.427**
K-Levels	Zero K		16.26	15.83	3.10	3.28	9.75	9.51
	50 K_2O		17.18	17.04	3.41	3.75	10.75	11.01
	100K_2O		17.90	17.72	3.61	4.06	11.458	12.05
L.S.D 5%			**0.17**	**0.15**	**0.09**	**0.11**	**0.609**	**0.42**

apple fruits quality (anthocyanine, starch and TSS) during the two growing seasons.

5.1. Main effect

The obtained values in Table (8) were (17.26 and 16.97) for anthocyanine mg/100gr fresh weight for horse and cattle manure, (3.38 and 3.36) for starch percent and (10.97 and 10.33) for total soluble solids in first investigation season and likewise the same trend in the second season. These results are in accordance with that obtained by Abd El-Naby (2000), Gobara *et al*. (2001), Abd El-Aal *et al*. (2001) and Eman *et al*. (2008).

5.2. Interaction effect

Combined effect of organic amendment type, type of potassium and three potassium levels presented in Table (8) indicated that anthocyanine, starch and TSS significantly increased by adding horse manure and increasing the rates of potassium fertilizer (in form of KCl) in both seasons. Attaela (1997) and El-Morshedy (1997) they reported that potassium fertilization on apple trees caused increased in fruit weight, fruit TSS and total sugars. These results are in harmony with that obtained by Gilberto Nava *et al*. (2008) they indicated that potassium fertilization positively affected fruit color and TSS on Fuji apple cv. Generally, $20m^3$ horse manure/ fed/ year + 100 Kg K_2O (KCl)/ fed/ year gave the best results.

6- Fruit quality 2

Data accessible in Table (9) highlight main and interaction effects of the three tested factors in trial on Anna apple fruit quality. The obtained results showedthat their was significant property due to the treatments on the apple fruit quality fruit firmness, total sugars and titratable acidity during the two growing seasons.

6.1. Main effect

Table (9) cleared value were (0.82 and 8.81) for fruit firmness (lb/ $inch^2$), (7.65 and 7.16) for total sugars percent and (0.76 and 0.82) for titratable acidity for horse and cattle manure during the first season and likewise the obtained data gave the same trend in the second season. The results indicated that horse manure more pronounced than cattle manure in enhancing fruit firmness, total sugars and decreasing acidity with non significant differences during two growing seasons.

6.2. Interaction effect

Interaction effects of organic amendment type, potassium type and potassium rate fertilizer to Anna apple trees on the fruit quality were presented in Table

(9). It is comprehensible that all most interactions were statistically significant. This was clear with all considered quality parameters. Nearly all prominent increases in fruit firmness and total sugars but acidity was decreased. The obtained results were in agreement with these reported by El-Kouny *et al*. (2004), Neilsen *et al*. (2004), Awad and El-Shenawi (2005) and Moulton *et al*. (2007).

7- Leaves mineral content

Data presented in Table (10) show that main and interaction effects of the three tested factors including organic amendment type, type of potassium and rate of potassium. The results indicated that there were significant effects due to the treatments on the Anna apple leaves macronutrients including N, P and K % during the two growing seasons.

7.1. Main effect

Significant differences between N, P and K % due to the organic amendment type were presented. The results indicated that horse manure more effective than cattle manure in supplying N, P and K during the two growing seasons. The highest results recorded in Table (10) were (1.99 and 1.71) for leaf N percent, (0.22 and 0.19) for leaf P content percent and (1.368 and 1.305) for leaf K percent for horse and cattle manures, respectively, in first season and the same trend was obtained in the second season. Gething (1986) found K supply to the plant affects nitrogen efficiency. But there is evidence of a more direct connection between the two elements, that K ion acts as a carrier for nitrate from the root to the leaf, where proteins are synthesized. Also K ion, being very mobile, promotes the uptake of the nitrate by the root. These results were similar to those of Agnello *et al*. (1999) and Magda (2002).

7.2. Interaction effect

Combined effects of organic amendment type, type of potassium and three of potassium levels on the N, P and K content were presented in Table (10). Most possible interactions for N, P and K were statistically significant, which indicate a high degree of interdependence between the studied factors. The most pronounced increases in N, P and K were obtained for the combination of horse or cattle manure with high rate of KCl in both growing seasons. Generally, results in Table (10) revealed that increasing the rates of potassium sulfate or chloride and adding organic manure associated with a gradual and significant increase in percentage of NPK in leaves of Anna apple trees in both

Table 9. The effect of animals manure and potassium fertilizers on fruit firmness total sugars and titratable acidity of Anna apple trees

Treatments			Fruit firmness (lb/inch^2)		Total sugars (%)		Titratable acidity (%)	
			2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010
Cattle manure	K_2SO_4	0	8.30	8.60	7.00	7.20	0.92	0.84
		50	8.50	8.90	7.30	7.60	0.81	0.73
		100	8.90	10.20	7.60	7.80	0.72	0.72
	KCl	0	8.50	8.80	7.10	7.10	0.93	0.85
		50	9.10	10.60	7.40	7.70	0.85	0.72
		100	9.70	11.10	7.70	8.30	0.73	0.67
Horse manure	K_2SO_4	0	8.80	8.90	7.20	7.40	0.87	0.78
		50	9.20	9.70	7.60	7.80	0.78	0.67
		100	9.50	10.80	7.90	8.60	0.70	0.64
	KCl	0	8.70	8.80	7.20	7.30	0.88	0.76
		50	11.40	11.50	7.60	8.40	0.68	0.66
		100	11.50	12.50	8.30	8.80	0.64	0.61
L.S.D. 0.05			**0.75**	**0.81**	**0.09**	**0.05**	**0.08**	**0.08**
Manures	Cattle		8.81	9.507	7.16	7.66	0.82	0.752
	Horse		9.82	10.215	7.65	7.95	0.76	0.692
L.S.D 5%			**1. 41**	**0.85**	**0.67**	**0.19**	**0.09**	**0.06**
K-Type	K_2SO_4		8.83	9.66	7.27	7.65	0.80	0.73
	KCl		9.80	10.22	7.54	7.95	0.78	0.71
L.S.D 5%			**0.40**	**0.39**	**0.46**	**0.87**	**0.02**	**0.03**
K-Levels	Zero K		8.53	8.716	6.83	7.30	0.89	0.81
	50 K_2O		9.52	10.166	7.5 0	7.91	0.78	0.70
	100K_2O		9.93	10.524	7.9 0	8.20	0.70	0.66
L.S.D 5%			**0.38**	**0.385**	**0.51**	**0.15**	**0.04**	**0.03**

Table 10. The effect of animals manure and potassium fertilizers on leaf N, P and K content of Anna apple trees

Treatments			N (%)		P (%)		K (%)	
			2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010
Cattle manure	K_2SO_4	0	1.70	1.73	0.19	0.18	1.22	1.02
		50	1.72	1.77	0.18	0.18	1.27	1.41
		100	1.73	1.75	0.19	0.19	1.37	1.67
	KCl	0	1.70	1.72	0.19	0.19	1.24	1.10
		50	1.72	1.76	0.19	0.18	1.35	1.60
		100	1.73	1.77	0.18	0.19	1.40	1.64
Horse manure	K_2SO_4	0	1.87	1.87	0.21	0.24	1.30	1.21
		50	1.95	2.02	0.21	0.24	1.39	1.44
		100	2.09	2.09	0.21	0.23	1.43	1.65
	KCl	0	1.88	1.89	0.21	0.23	1.32	1.23
		50	2.03	2.11	0.22	0.23	1.37	1.61
		100	2.09	2.05	0.22	0.23	1.42	1.71
L.S.D. 0.05			**0.03**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**
Manures	Cattle		1.71	1.71	0.19	0.19	1.31	1.39
	Horse		1.99	2.01	0.22	0.23	1.37	1.47
L.S.D 5%			**0.14**	**0.22**	**0.02**	**0.04**	**0.07**	**0.20**
K-Type	K_2SO_4		1.84	1.84	0.20	0.21	1.33	1.40
	KCl		1.86	1.87	0.20	0.21	1.34	1.47
L.S.D 5%			**0.05**	**0.07**	**1.80**	**0.01**	**0.01**	**0.03**
K-Levels	Zero K		1.79	1.80	0.20	0.21	1.26	1.11
	50 K_2O		1.85	1.86	0.20	0.21	1.35	1..51
	100K_2O		1.91	1.92	0.20	0.21	1.40	1.67
L.S.D 5%			**0.08**	**0.09**	**0.01**	**0.01**	**0.02**	**0.08**

seasons. These results were similar to those of Andrzinj Komosa and Adam Szewezuk (2003); Neilsen *et al*. (2004); Awad and El-Shenawi (2005); Fayed (2005) and Neilsen and Neilsen (2007).

In all Tables, horse manure and potassium chloride increased number of leaves/ shoot, leaf area, number of flowers/ cluster, fruit set %, fruit weight (gm), length (cm) and diameter (cm), yield (kg/ tree and ton/ fed), anthocyanine (mg/ 100gm), starch %, total soluble solids %, fruit firmness (lb/ $inch^2$), total sugars % and leaf (N content %, P content % and K content %) in two seasons. On the other hand, titratable acidity was decreased. Finding of many investigated gave a real support to our results, Awad and El-Shenawi (2005); Eman *et al*. (2008) and Eman *et al*. (2010).

CONCLUSION

From the results of this investigation, it could be concluded that fertilization of Anna apple trees with organic manure (horse or cattle)20 m^3/feddan /year plus 100 kg k2O/feddan / year seems to be the promising treatment to produce the highest vegetative growth ,yield characters, fruit quality and mineral composition. This treatment is considered to be recommended for fertilizing Anna apple trees under the prevailing conditions of this study. It will keep out environment clean, decrease the environment pollution and fertilizers loss resulted from applying high rates.

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الملخص العربي

أنَا العضوى والبوتاسى على نمو ومحصول وجودة ثمار التفاح صنف تأثيرالتسميد

مُحَمَّد رجب الشناوى، مُحَمَّد السيد مرسى

اجريت هذه الدراسه فى مزرعة خاصه بمنطقة العكريشة–كفر الدوار– محافظة البحيره على اشجار تفاح صنف انّا مطعومة على اصل بلدى عمرها 8سنوات تحت نظام الرى السطحى خلال موسمى النمو 2008/ 2009 و2010/2009 والهدف من البحث هو تقدير استجابة اشجار التفاح الانا لنوع السماد العضوى (ماشيه او خيل) بمعدل 25 كيلو جرام/ شجرة/ عام (20 م3/ف) مع نوعين مختلفين من التسميد البوتاسى (كبريتات وكلوريد بوتاسيوم) مع ثلآث مستويات من كل نوع هى صفر ،50 ، 100 كجم اكسيد بوتاسيوم/ فدان/ سنه.

أوضحت نتائج الدراسه ان السماد العضوى للخيل كان اكثر تأثيرا من سماد الماشيه على تحسين الصفات المدروسة (عدد الأوراق لكل فرع ومساحة الورقة وعدد الأزهار لكل دابرة ونسبة الثمار العاقدة ووزن وطول الثمرة وقطرها والمحصول والنسبة المئوية لكل من الأنثوسيانين والنشا والمواد الصلبة الذائبة الكلية ومتوسط صلابة الثمار بالرطل/بوصة مربعة والنسبة المئوية لكل من السكريات الكلية والحموضة ومحتوى النيتروجين والفوسفور والبوتاسيوم في الأوراق)، كما أوضحت النتائج أن زيادة معدل تركيز البوتاسيوم للنوعين (كبريتات أو كلوريد بوتاسيم) إلى 100كجم أكسيد بوتاسيوم لكل فدان أدى إلى زيادة معنويه لكل الخصائص المختبره مقارنة بالكنترول (صفر أكسيد بوتاسيوم). ومن ناحية أخرى اعطى كلوريد البوتاسيوم أفضل النتائج في تحسين كل الصفات المدروسه بالمقارنه بكبريتات البوتاسيوم. كذلك اوضحت النتائج ان أفضل معامله كانت عند استخدام 20م3 سماد عضوى (خيل او ماشية)/ فدان/عام مع 100 كجم أكسيد بوتاسيوم (كلوريد أو كبريتات) وبلغ المحصول 21، 17 طن/ فدان/ عام بالنسبه للسماد العضوى (الخيل او الماشيه) على التوالى مقارنه بالكنترول 11 طن/ فدان / عام.