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THE EFFECT OF ORGANIC AND MINERAL FERTILIZERS ON YIELD AND THE CONTENTS OF NO_2 AND NO_3 IN SPINACH LEAVES.

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ABSTRACT

A field experiment was conducted at Lattakiia during the two successive seasons of 2005-2006 to study the effect of mineral and organic fertilizers on yield and NO_2 and NO_3 contents in spinach leaves.

The results showed that spinach leaves in the first and second cut were free from NO_2 in case of all treatments used. Moreover, the results indicated that application of Urea and organic fertilizers gave rise to highest yield with less NO_2. Likewise, application of balanced solvable (N:P:K) gave a moderate yield and less NO_3 content. On the other hand, ammonium nitrate and ammonium sulfate led to less productivity and on olives increase in NO3 spinach leaves.

INTRODUCTION

Spinach (*Spinacia Oleracea*) which is an annual, quick growth and ripeness plant belongs to the Chenopodiaceous family. Its leaves are to be eaten cooked, and it is considered among the important leafy vegetable harvests in the freezing and conning industries. A kind of powder is extracted from its dry leaves. The powder is rich in mineral salts, and it is prescribed for stomach and viscera patients who can't have large amount of fresh vegetables. The juice of spinach is used in canning factories to give canned peas the desired green color, Al– Warea (1978).

Spinach is considered one of the vegetable crops rich in the nutritional values as its leaves contain 6 – 16 % dry substances, in addition to amino acid, proteins, fats, vitamins [A, C, D, K and E], vitamins [B] and many mineral salts of which the most important are potassium, sodium, magnesium, ferrate, phosphor, calcium as well as some zinc, cooper, iodine, and molybdenum, Al–Warea (1978).

Spinach is distinguished for containing easily digested absorbed ferrate, that's why it is, prescribes for people suffering from anemia and nervous cases. It also stimulates the digestive, and nervous systems. Minerals fertilization in general and N fertilizations in particular are among the important elements in developing plants and increasing the production, but the increase of the amounts and the random use of the fertilizers cause the accumulation of NO_3 in vegetable crop, Hassan (1991) and thus leading to the appearance of different poisoning syndromes on people who have large amounts of vegetables contaminated with NO_3 and NO_2. The thing that appears in a state of dizziness, body weakness [planes], Evanova (1991) and Garathon (2003). Large amount of NO_3 in food are poisonous for humans, because when reaching the blood, NO_3 ion causes changing

changing the ferrate in blood hemoglobin into ferrate ion resulting in a methenoglobin, incapable of carrying oxygen ingredient.

NO3 may enter a process of exchange with amino and amide resulting in nitrosamine, which is considered one of the composites causing digestive system cancer.

Human body tolerates the concentration of NO3 to a certain rate and the average body endurances of NO3 is estimated by (5 mg/kg of body weight) which equals (300-350 mg for adults), (10 mg for children) of which more than 70% is obtained from fresh vegetables, Danek (1990) and Basalyko (2002).

Due to the importance of this issue and its effect on health, some progressive countries issued legislations which adjust the maximum of NO3 and NO2 and other composites, aiming at producing healthy food.

Table (1): Amount of allowed NO3 and NO2 in some vegetables estimated by mg/kg fresh weight, Beksslevel (1998).

Product / Crop	NO3	NO2
– Pepper, tomato, cucumber	200 - 400	5
– Pumpkin, curette	700	5
– Green vegetables	1000	10
– Rolled vegetables	600	10
– Root vegetables	500	10
– Dry onion	100	-
– Garlic	200	-
– Legumes	300	5

The amount of NO3 in vegetables depends on many factors. Some of the factors are hereditary, where the amount of NO3 differs from one species to another, even among the crossbreeds and varieties within the same species. Green vegetables (lettuce, spinach, parsley, chord, and spring onion) contain large amount of NO3, while the amount decrease in legumes and fruits Gantsarkia (1990), Nieuwhdf (1989) and Ragion *et al* (2002).

Hassan (1991) indicates that hereditary factors have a great role in the content of NO3 in some spinach species and other vegetables. He also indicated that NO3 accumulated in spinach with the increase of azotic fertilization, more in light than in dark and in sunny than in cloudy days.

Evanova (1999) and Piztocikov (2001) were interested in studying the effect of fertilizers amount of NO2 in spinach leaves, they showed that the leaves were free from this substance when using effective azotic with amounts less than 165kg/hectare, with some differences concerning the types of the used fertilizers.

The results of Basalyko (2002) and Blom and Zandstar (1998) showed the effect of NO_3 in vegetables, where the amount decreases by good lighting and long days, while it increase by good lighting and long days, while it increases by bad lighting and short days, as well as by high humidity and changing temperature.

When studying the effect of lighting on the content of NO_3 in spinach leaves, Paschold (1989) and Chabijaa *et al* (1999) results showed the increase of this substance by 50% during fall compared with spring. The study also showed that the increasing light from 50 to 7000 kg in fall caused decrease of NO_3 by 120-340% when planting spinach in shady areas compared with good lighting conditions.

Scharpf (1985), Maladkof (2002) and Bekssieve (1998) referred the increase in the amount of NO_3 in the vegetables grown in a soil rich in organic materials without adding mineral fertilizers to increase activity of organism, the decomposition of organic fertilizer, and production of mineral azote absorbed by plants (1kg povine fertilizer gives 4-5 g effective azote).

Nes *et al* (1989) and Paschold (1988) results indicated the increase in the amount of NO_3 in the early ripened spinach species and species with wrinkled leaves compared with late ripened species and species with flat leaves. The study also emphasized the increase of the amount of NO_3 in spinach when increasing the level of azotic fertilization, where the amount of NO_3 in leaves reached 952mg/kg of fresh substance in the fertilized plants, and it reached 1338 and 2160 mg/kg when fertilizing with 80-160kg of effective nitrogenous/hectare successively.

Titz and Sommer (1989), Garrnca *et al* (2000), Venter and Fritz (1983) and Gantsarika (1990), showed the increase of the content of NO_3 in vegetables when using ammonium nitrate and calcium nitrate, while using urea or calcium creamed caused the decrease of NO_3 in the same species of vegetable crops. The difference in the content of NO_3 in parts of the vegetable crops was made clear, where the amount increases in the stems while it decreases in the blades, Garagolina (1998) and Shaipakov (2001).

Piztocihov (2001) and Glontsova (2001), showed that the lack of balance among the essential nutrient (N, P and K) in the soil caused the increase of NO_3 in vegetables, and that the minor nutrients have a great role in decreasing the amount of NO_3 in vegetables.

The research aims at studying the effect of nitrogenous fertilizer on the production of spinach and its subsequent effect on the quantity of the leaves, mainly their content of composites resulting from using different kinds of nitrogenous fertilizers, i.e. NO_2 and NO_3.

The importance of this research arises from the scientific tending to study the effect of some health-affecting composites of different minerals fertilizers, especially nitrogenous ones, on the content of spinach leaves.

MATERIALS AND METHODS

The experiment was conducted using the local species of spinach, in Jabla, Arrmaila and Lattakia.

The seeds were sown in rows with intervals of 25 cm, and the depth was 1.5-2 cm with the average of $3g/m^2$. The process took place on 25/11/2005 and the seeds grew completely in a week 2/12/2005.

The experiment was performed using the design of random complete blocks on a piece of land with the area of 50 m^2, knowing that the number of the experimental units was 6, where each contained four with the area of $1m^2$ each.

The treatments were applied as follows:

T_1 without fertilization

T_2 fermented cows manure 4 kg/m^2

T_3 46% urea 30 g/m^2

T_4 33% ammonium nitrate 42 g/m^2

T_5 21% ammonium sulfate 68 g/mg

T_6 balanced solvable fertilizer: N:P:K, 20:20:20 which contains the minor elements 70 g/m^2 knowing that the amount of the nitrogenous fertilizers was calculated on the basis of 14 g m^2, i.e. by the regular average of the needs of spinach crops 14 kg $N/1000m^2$.

Nitrogenous fertilizers were added at two stages:

- The first stage: after 15 days of the growing (half the amount).
- The second stage: one month after the first stage (the other half of the amount).

Essential phosphatic and potassic fertilizers were added during the process of preparing the land for sowing (T_3, T_4 and T_5) adding 20kg P_2O_5 and K_2O per $1000m^2$. Normal agricultural practices have been carried out.

Data recorded:

1) Calculating the productivity in the area through a succession of two harvests.
2) Calculating the content of NO_3 and NO_2 in the leaves as follow:

- NO_2 and NO_3 were extracted using hot water method as follow:

- Squashing a random specimen of spinach leaves using a blender.
- Using 50g of the extract in 100 ml glass.
- Adding 50 ml of filtered water heated for 15 minutes after boiling.
- Completing the size with filtered water up to 100 ml.
- Estimating NO_2 and NO_3 by Merck Reflex using Merck Chips for estimating NO_2 and NO_3 separately.

- Estimating the amount of NO3 and NO2 (mg/kg fresh weight) in the following equation:

$$\text{Mg/kg fresh weight (NO2, NO3)} = \frac{R \times 100}{W}$$

R = reading of the device.
W = the weight of the plant specimen.

RESULTS AND DISCUSSION

1. The content of NO3 in the leaves:

According to table (2), it was noticed that the content of NO3 in the leaves in the first harvest T2 has increased notably, with the use of organic fertilizer (Cows manure) compared with the other treatments of the experiment. But the large amount of NO3 in spinach leaves, with the use of organic fertilizer, remained under the allowed minimum for leafy crops, which matches the results of Maladkof (2002), Scharpf (1985) and Bekssieve (1998).

Table (2): The content of NO3 in spinach leaves during the period of conducting the experiment (2005-2006).

Treatments	First harvest	Second harvest
	T / kg weight	
T1 Without fertilization	65	46
T2 Cows manure	945	846
T3 Urea	70	694
T4 Ammonium nitrate	102	1996
T5 Ammonium sulfate	98	1587
T6 Balanced solvable	0	129
L.S.D at 5%	79	234

Whereas in the second harvest of spinach crops, we generally notice the increase in the amount of NO3 in the leaves in all the treatments of nitrogenous fertilization, with differences from one treatment to another, where using N as ammonium nitrate or sulfate resulted if giving the largest amount of nitrate in spinach leaves, the thing that matches results obtained by Maladkof (2002) about spinach.

Whereas using urea and cows manure resulted in average content of NO3 in leaves which remained within the internationally allowed limit in leafy crops. Using fertilizer balanced by nutrients caused the decrease in the amount of NO3 in the leaves notably, which might be a result of the presence of the minor nutrients which regulates the absorption of N, and helps changing it into organic substances after being absorbed by the plant, which matches results obtained by Piztocikov (2001) and Glontsova (2000).

2. **The content of NO2 in the leaves:**

The experiment shows the absence of NO2 in the leaves in the first and second harvests and for all treatments. This shows that the amount and kind of used fertilizers in the experiment didn't produce NO2 in the leaves, which matches Evanova (1999) and Piztocikov (2001) findings.

3. **Yield:**

According to table number four, we notice that the best productivity was when using cows' manure, flowed by urea, while that least productivity was without using fertilization, and the total productivity of the treatments (T4, T5 and T6) was convergent.

Table (3): The productivity of spinach as a result of application of the different treatments (kg/m2) with the average of four.

Treatment	First Harvest	Second Harvest	Total production	
			Kg/m2	Kg
T1 Without fertilization	0.30	0.25	0.55	550
T2 Cows manure	0.70	1.07	1.77	1770
T3 Urea	0.62	0.72	1.34	1340
T4 Ammonium nitrate	0.45	0.65	1.10	1100
T5 Ammonium sulfate	0.42	0.67	1.09	1090
T6 Balanced solvable N.P.K	0.46	0.70	1.16	1160
L.S.D at 5%	-	-	0.002	

According to the table, we find that the total productivity of the treatments ranged from 1110 to 1770kg/100m2 which matches the international productivity of this crops with the average of (12.000–18.000 ton/hectare).

Depending on the finding of tables 3 and 4 we find that using cows manure and urea resulted in high productivity, with the least of NO3, followed by the balanced solvable NPK which resulted in average productivity and the least of NO3. Whereas using ammonium nitrate and sulfate resulted in relatively low productivity while it increased the content of NO3 in spinach leaves.

Finding and Recommendations

The study of the amount and kind of the crop by using different azotic sources shows the following:

1. The importance of N as a major element.
2. The difference in the effect of N sources on productivity and on the subsequent content of NO2 and NO3 in leaves.
3. The importance of studying N fertilization on the quality of leafy crops.
4. Deepening the study by using different levels of N fertilization and other sources of organic fertilization in successive seasons to find out the remaining effect of the fertilizers on the quality of the vegetable crops.

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تأثير الأسمدة المعدنية والعضوية على محصول السبانخ ومحتوى الأوراق من النترات والنيتريت

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اجري البحث في مدينة اللاذقية عامي ٢٠٠٥-٢٠٠٦ م ، حيث تمت دراسة تأثير إضافة الأسمدة المعدنية والعضوية على محتوى نبات السبانخ من النترات والنيتريت ونوعية الأوراق الناتجة. ومن خلال نتائج البحث تبين خلو الأوراق من النيتريت في الحشتين الأولى والثانية ولجميع المعاملات.

كما بينت نتائج البحث أن استخدام اليوريا والسماد العضوي أعطى أعلى إنتاجية وأقل محتوى من النترات ، كما أن استخدام السماد المتوازن NPK أعطى إنتاجية متوسطة وأقل محتوى من النترات.

أما استخدام نترات الامونيوم وسلفات الامونيوم فقد أدى إلى إنتاجية منخفضة للمحصول نسبيا وزيادة في محتوى أوراق السبانخ من النترات.