RESEARCH PAPER

Comparison of nitrate content in soil of vegetables farms in Tehran

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Keywords
nitrate content
soil
vegetables farms
Tehran

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Abstract

Nitrate is found naturally in foods and in high concentrations in certain vegetables. Nitrogen is the main limiting factor for most field crops, and nitrate is the major from of nitrogen absorbed by crop plants. Farmers often use nitrogen fertilizers to increase crop yields. Nitrate itself is relatively non-toxic but its metabolites may produce a number of health effects. In our studies (in the South of Tehran), farmers use higher amounts of fertilizers than they should, either due to their ignorance, or because they want to increase their production quickly when the prices of their products in markets are high. The goal of this survey was to demonstrate the effects of environmental factors such as soil quality, as well the effect of farming practices and fertilizers types and amounts, on nitrate content in lettuce and spinach. In winter, spring and summer 2011 five conventional and greenhouse farms in the south of Tehran were chosen for the field survey. 150 lettuce plants and 60 spinach plants from 2 to 6 locations were sampled. A pair of conventional and greenhouse fields that have been managed by the same grower was selected to compare the effect of farming practices on nitrate content in Romania lettuce, on the other hand 3 farms compare with each other due to the kind of fertilizers using. All fields are located in the south of Tehran, Baghershahr and Share-ray. The results of the greenhouse spinach fields survey show that not only the kind of greenhouse fertilizers applied, but also soil characteristics, can significantly affect nitrate levels in plants. spinach grown using cow manure tended to contain higher nitrate that spinach grown using compost.

Introduction

Nitrates and nitrites seem to be among the chemicals that may cause pollution; many studies have expected the effect of these compounds on the environment and on the living health. Nitrogen is the main limiting factor for most field crops, and nitrate is the major from of nitrogen absorbed by crop plants. Farmers often use nitrogen fertilizers to increase crop yields. The main anthropogenic sources of nitrates in the environment are municipal and industrial wastes and artificial fertilizers (Michalski and Kurzyca, 2006). Nitrate itself is relatively non-toxic but its metabolites may produce a number of health effects (Mensinga et al, 2003). In order to control the nitrate and nitrite intake by consumers in general and on babies in particular who are the most vulnerable to the advance effects of these two compounds, a maximum accept-able limit of these compounds were suggested. The Acceptable Daily Intake (ADI) of nitrate and nitrite set by European Commiss-ion's Scientific Committee for Food (ECSCF), is 3.7 mg/kg body weight, and 0.06 mg/kg body weight, respectively (Ministry of Agriculture and Fisheries and Food, 1994, CECSCF, 1992).

In our studies (in the South of Tehran), farmers use higher amounts of fertilizers than they should, either due to their ignorance, or because they want to increase their production quickly when the prices of their products in markets are high (Ziarati, 2010) Plants cannot utilize all the added fertilizers, so the excessive amounts will be widespread by irrigation water through the soil to reach ground water, or it may dissolve in runoff water and flows into streams or takes and rivers. Nitrogen compounds are also accumulates in some plant issues. The previous results on NO_3 content in vegetables from greenhouse in Tehran were all significantly higher than those grown in open-fields (Ziarati, 2011). The goal of this survey was to demons-trate the effects of environmental factors such as soil quality, as well the effect of farming practices and fertilizers types and amounts, on nitrate content in lettuce and spinach.

Materials and Methods

In winter, spring and summer 2011 five conventional and greenhouse farms in the south of Tehran were chosen for the field survey. 150 lettuce plants and 60 spinach plants from 2 to 6 locations were sampled, according to field size. Plant samples were immediately transferred to color boxes. After plant samplings, a shallow soil profile of 40 to 45 cm depth was collected at each point where plant samples were removed. Soil profile characteris-tics were observed and recorded by a pocket penetrometer (CL–700 A, Soil Test Inc., USA). Soil samples were mixed, homogenized and separated into halves. Half of each sample was air –dried and passed through a 2 mm sieve and used to determine pH (1:1) and electrical conductivity (EC 1:1). The other half was passed through a 2 mm sieve without drying and used to determine nitrate and ammonium (2M KCl extraction followed by determination using flow injection method, potentially mineralizable nitrogen (PMN) and moisture content. PMN was measured in duplicate for surface layers. All the soil data are expressed on a dry weight basis. Results from paired fields were analyzed using a one-way ANOVA for the difference between conventional and greenhouse fields.

Results and Discussion

Table 1 Chemical characteristics of the soil profile at the experimental field in Baghershahr. (Prefertilizing)

Layer (depth cm)	pH (H_2O)	Electrical conductivity dS/cm 1:1	NO_3-N mg/kg DW	NH_4-N mg/kg DW
1 (0 - 15)	6.4	0.44	60.9	9.65
2 (15 -30)	6.5	0.23	20.5	8.30
3 (30 -45)	6.6	0.14	3.69	4.40

Table 2 Nitrate accumulation in crops and soils from 5 locations in South of Tehran fields by comparing the water irrigation system.

	F_1 Baghershahr	F_2 Share-ray	F_3 Share-ray	F_4 Beheshtezahra	F_5 Beheshtezahra
Crop (first harvest)	Spinach	Spinach	Spinach	Spinach	Spinach
Growth period	30 days	46 days	46 days	57 days	56days
NO_3 mg/kg FW (whole)	5200	6700	6500	6300	6100
NO_3 mg/kg FW (petioles)	4000	5000	4100	3900	3800
Crop (first harvest)	Romania lettuce	Romania lettuce	Romania lettuce	Romania lettuce	Romania lettuce
NO_3 mg/kg FW (whole)	3028	3781	3045	3899	3675
Fresh weight g/plant	5.6	15.6	11.7	12.4	18.0
Soil type (0-15cm) pH 1:1	7.4	6.8	7.1	7.0	6.9
EC 1:1 dS/m	0.48	0.32	0.33	0.45	0.47
NO_3 –N mg/kg DW	56.1	48.0	21.3	22.8	27.8
NH_4-N mg/kg DW	2.72	3.16	2.72	4.83	3.25
PMN mg/kg DW	13.9	35.0	32.0	28.3	29.1
Irrigation water	City water	Ground water	Ground water	Ground water	Ground water

A pair of conventional and greenhouse fields that have been managed by the same grower was selected to compare the effect of farming practices on nitrate content in Romania lettuce, on the other hand 3 farms compare with each other due to the kind of fertilizers using. All fields are located in the south of Tehran, Baghershahr and Share-ray.

Chemical characteristics of the soil profile are shown in the table 1.Data is averages of two profiles.

At the share-ray farms, the grower applied farm-made compost. The texture of the Romania field's soil was sandy. Topsoil pH was 6.8. Nitrate content in soil was the highest among surveyed fields, reaching 48 mg-N/kg in topsoil and 29 mg-N/kg in subsoil. PMN content in topsoil was 35 mg-N/kg, which was also the highest of farms surveyed. Near Beheshtezahra farms' soil analysis showed that the field which had the highest nitrate accumulation both in topsoil (22.8 mg-N kg) and subsoil (39.8 mg-N kg) but the lowest PMN (13.9 mg N- kg) surveyed used cow manure. PMN content in this field's topsoil was as low as 59% of the average of the other greenhouse fields. Results show that in the field that used compost, the second harvest spinach contained considerably lower nitrates than the first one. It was also found out that nitrate level in the topsoil under the first harvest spinach was higher than nitrate content in the subsoil. At all fields, soil pH at 0-25 cm deep ranged from 6.6 to 7.4 which appeared to be an acceptable range for spinach growth. Ammonium content was less than 5 mg n/kg at all the fields, indicate ting that the nitrification process had been taking place normally.

Although soil type was different between fields, nitrate content in conventional and greenhouse Romania lettuce at the paired fields was not significantly different. The same fertilizers might cause the comparable nitrate content seen in the greenhouse and conventional plants. High nitrate content (over 2000 mg/kg) in Romania lettuce was observed at the Share-ray greenhouse fields. In table 2 we can see the soil's analysis and nitrate accumulation in crops and soils by comparing their water irrigations.

Conclusion

Accumulation of nitrate content and PMN in soils, which is considered as a result of long- term compost applications, may explain a part of this nitrate accumulation in lettuce and spinach plants. Since the sample was taken from limited space, this result does not represent the whole fields. However, this case shows that potential of nitrate accumulation in crops and soils at the fields based on compost application. That is, even compost –based applications may not always be safe when compost has been continuously applied for more than 10 years.

The results of the greenhouse spinach fields' survey show that not only the kind of greenhouse fertilizers applied, but also soil characteristics, can significantly affect nitrate levels in plants. That is, although spinach grown using cow manure tended to contain higher nitrate that spinach grown using compost. In conducting these experiments, we also observed that there is also a higher risk of contaminating ground water with nitrates when over fertilization takes place that should be considered in the following surveys. Although further research is needed to

determine the actual factor involved, it is obvious that differences in soil texture may affect nitrate movement in soils, and hence, nitrate content in plants.

Acknowledgment

Financial Supports from Pharmaceutical Sciences Branch, Islamic Azad University (IAUPS) is gratefully acknowledged.

References

Michalski R and Kurzyca I. Determination of nitrogen spieces (nitrate, nitrite and ammonia ions) in environmental samples by ion chromatography. Polish J Environ Studies 2006;15:5-18.

Mensinga TT, Speijers GJA and Meulenbelt J. Health implications of exposure to environmental nitrogenous compounds. Toxicol Rev 2003;22:41–51.

Ministry of Agriculture and Fisheries and Food. Total diet study:nitrate and nitrite. Food Surveillance Information Sheet. No 137. Published City:Publisher; 1994.

Commission of the European Communities Scientific Committee for Food (CECSCF). Report of Scientific Committee for Food on nitrate and nitrite. Series no. 26. Opinion Expressed, 19 October 1990. EUR.13913. 1992.

Ziarati P. Seasonal fluctuation in nitrate pollution in Tehran's lettuce. 2nd Asian Conference On Environmental Mutagens, Harmonize Gene & Environment Asian Health Promotion, ACEM, Pattaya, Thailand, 2010.

Ziarati P. Assessing the health risk of nitrate content in vegetables to the general population In Tehran, Iran 11th International Congress of the Iranian Society of Toxicology, Mashad-Iran, 2011.