Rational Nitrogen Fertilization Plans for selected crops in dry and wet regions of Turkey

Th. KARYOTIS[1], A. PANAGOPOULOS[2], Kat. KARYOTI[2], M. TZIOUVALEKAS[1], Ali KASACI[3] and Ibr. GÜÇDEMIR[4]

[1] Institute for Soil Mapping and Classification, Larissa, GREECE
[2] Land Reclamation Institute, Thessaloniki, GREECE
[3] Ministry of Food, Agriculture and Livestock, Ankara, TURKEY
[4] Soil, Water and Fertilizer Resources Central Research Institute, Ankara, TURKEY

Lisbon 29 April 2015

Nitrogen fertilization plans

In order to implement the Nitrates Directive in Turkey, rational nitrogen fertilization plans were suggested for the main crops.

A set of factors was used to formulate a nitrogen balance sheet, for the various climatic zones of Turkey.

Factors have been taken into consideration:

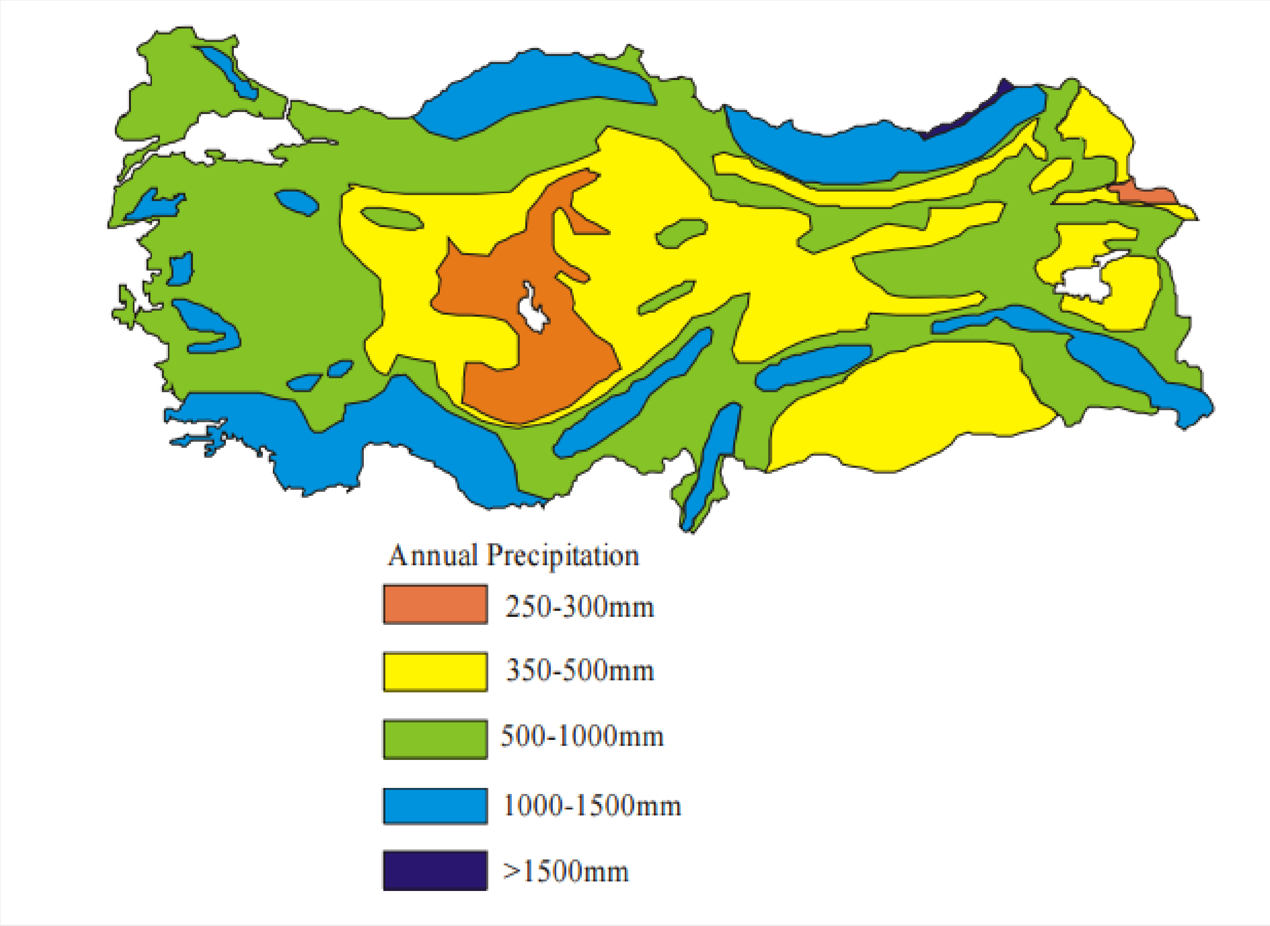
-nitrogen uptake by plants for a targeted yield
-nitrogen losses (leaching, emissions)
-residual nitrogen
-input from rainfall or irrigation
- amount of nitrogen mineralisation.

Climate of Turkey

-Climatic conditions in Turkey varies greatly, and Turkey has been classified into seven agri climatic zones

Figure 1 Distribution of mean annual precipitation in Turkey

(State Meteorological Directorate, 2010)



The components of a rational fertilization plan for the main crops of Turkey

To calculate the required nitrogen per each crop, a Microsoft Office Excel spread sheet was compiled. The components for N fertilization plans are:

$$N_f = N_{req} - [(N_m + N_{in} + N_r) - (N_l + N_d + N_v + N_{runoff})]$$

where: N_f is the quantity of recommended N fertilizer
N_{req} is the total N required to produce a crop of a targeted yield
N_m is N released from crop residues and mineralized from SOM
N_{in} is the residual plant available inorganic N
N_r is the N input from rainfall
N_l, N_d, and N_v are N losses through leaching, denitrification, and volatilization
N_{runoff} is the quantity of N lost by runoff in the sloping areas

Table 1: Textural soil classes used for N fertilization

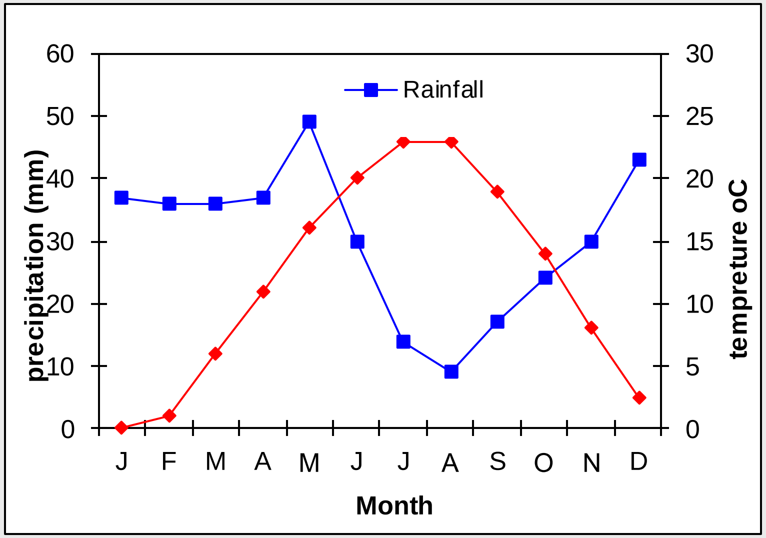
Soil class	General soil texture	Mean clay% used for calculation of N leaching	SOM %	Nmin (kg/da)*
I	Light	15	1%	1.0
III	Heavy	40	3%	4.0

10 da*= 1 ha

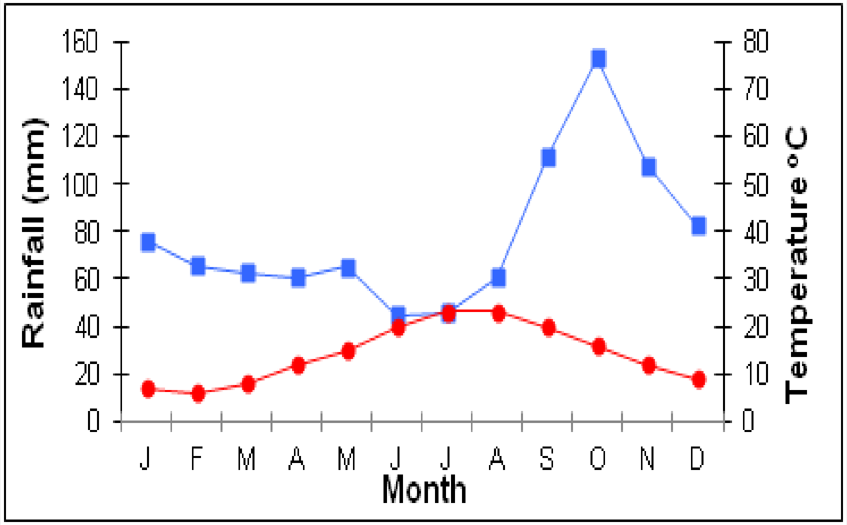
Table 2 Nitrogen and total water requirements for certain yield of the main crops in Turkey *

Crops	**Targeted yield** (kg /da)	**Required Nitrogen** (kg/da)	**Water requirements** (mm/y)
Apple-pear trees	4500	23	712-800
Corn	1200	24	780
Wheat	400	10	446
Sugar beet	9000	18	827
Potatoes	3000	14	465

Soil, Water and Fertilizer Resources Central Research Institute, Ankara



Ombrothermic diagramme of Ankara



Ombrothermic diagramme of Trabzon

N mineralization (plant residues and manure)

In the absence of experimental results concerning the N mineralization dynamics in various soil classes, values were used in the fertilization plans (Table 4) which are almost similar with values used in the proposed fertilization plans for Greece (Karyotis et al., 2002).

Table 3 Nitrogen mineralization in various soil classes

SOM %	SOC %	Nmin (kg/da)
Class I 1%	0.58 %	1.0
Class III 3%	1.74%	4.0

Table 4 Values for residual nitrogen in the arable soils of Turkey

SOM %		Residual N (kg/da)
Class I	1%	2.0
Class III	3%	4.0

Table 5 Nitrogen inputs from irrigation

Nitrates (mg/l)	Quantity of irrigation water (m^3/da)				
	200	300	400	500	600
	Nitrogen inputs (kg/da)				
10	0.452	0.678	0.904	1.130	1.36
20	0.904	1.356	1.808	2.260	2.720
30	1.356	2.034	2.712	3.390	4.068
40	1.808	2.712	3.616	4.520	5.440
50	2.260	3.390	4.520	5.650	6.780

N deposition (wet)

The amount of nitrogen which originates from precipitation varies and the following quantities were used: 0.5 kg N/da/y and 1.0 kg N/da/y, for the respective rainfall regimes where the annual precipitation is 500 and 1.500 mm.

In general, annual nitrogen inputs from rainfall ranges between 3 and 5 kg N/ha in drier environments (McNeill and Unkovich 2007) and are higher in wet and polluted environments.

Nitrous oxide emissions

Emissions from commercial fertilizer use can be estimated using the following equation:

N_2O Emissions = (FC * EC * 44/28)

FC = Fertilizer Consumption (tons N-applied);
EC = Emission Coefficient = 0.0117 tons N_2O-N/ton N applied; and
44/28 = The molecular weight ratio of N_2O to N_2O as N(N_2O/N_2O-N).

Denitrification

An average value 16.8 kg N ha^{-1} (equivalent to 1.68 kg N da^{-1}) was suggested. This is the average value derived from 10 years experiments (David et al., 2006) in arable areas and seems to be at normal level.

Nitrates Leaching

In the absense of experimental data, various countries have used pedotransfer functions and leaching is included as a component of N fertilization plans.

De Willigen (2000) developed a regression model to estimate the amount of leached N. The pedotransfer function used in this report consists of the following factors:

$$N_{leaching}\,(kg/ha) = 21.37 + (P/C \times L) \times (0.0037 \times N_{f,r,m} + 0.0000601 \times O_c - 0.00362 \times N_u)$$

where:

P =	annual precipitation (mm/year);
C =	clay content (percent);
L =	rooting depth (m);
$N_{f,r,m}$ =	applied inorganic, residual and mineralized fertilizer N;
O_c =	organic carbon content of the soil (percent);
N_u =	N uptake by the crop (kg/ha/year).

Table 6: Effective rooting depth for selected crops (FAO, 1998)

Crop	Root depth under irrigation (m)	Rainfed conditions (m)
Tomato	0.75	1.5
Potato	0.5	0.7
Sugar Beet	0.75	1.2
Cotton	1.0	1.7
Wheat, Barley	1.0	1.5
Maize, (grain)	1.0	1.7
Apples, Cherries, Pears, Peaches	1.0	2.0

The smaller values may be used for irrigated crops and the higher values for rainfed conditions

Results and discussion

Amount of applied N (kg/ha) from inorganic fertilizers and manure in the provinces of Turkey

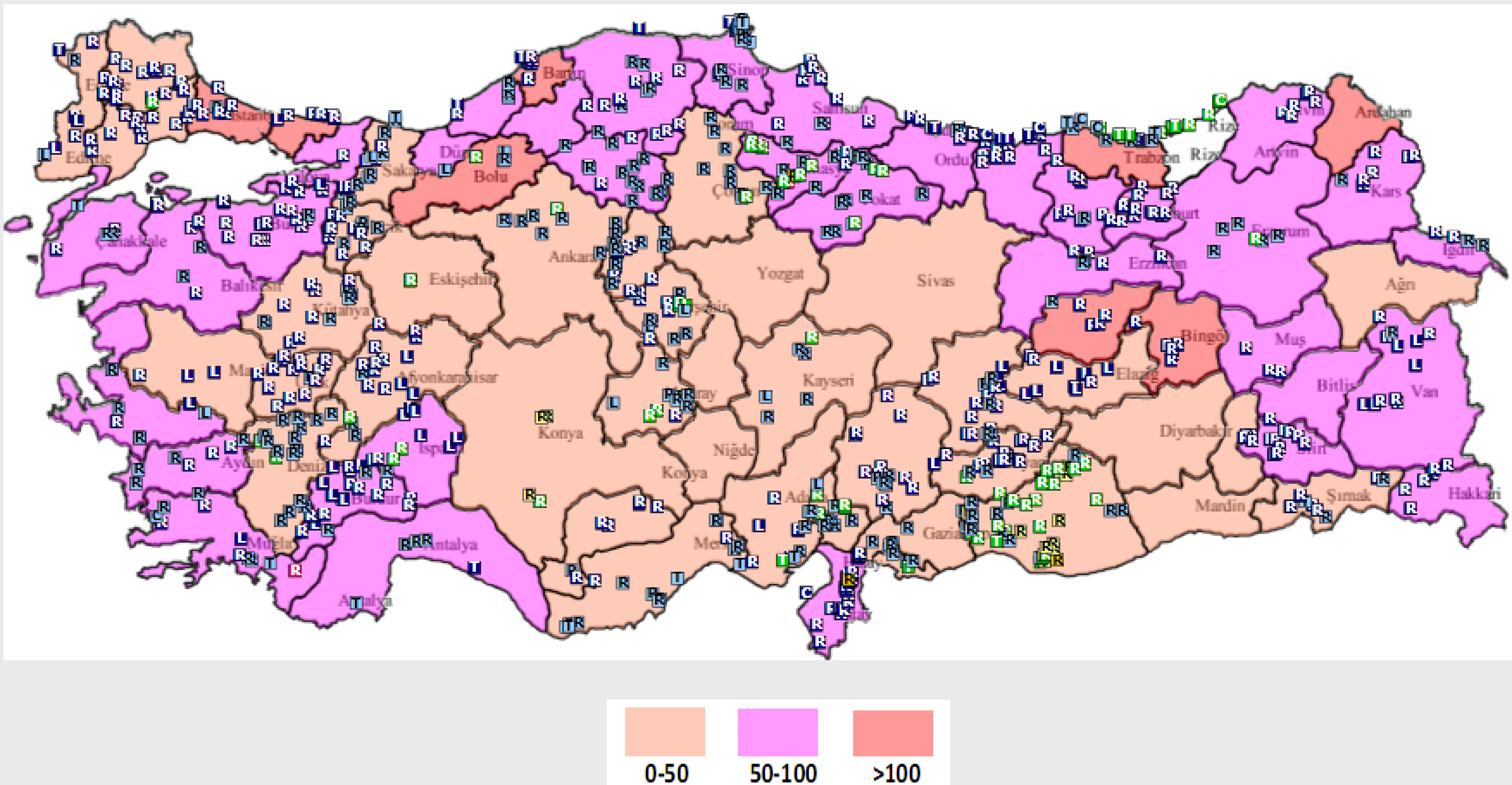


Table 7 Example for recommended N fertilization for corn in rainfall regime 500 mm/year

CORN	Soil Class I	Soil Class III
Required nitrogen (kg/da)	**24.00**	
Soil texture(decreased biomass production)	**Soil Class I (-30%)**	**Soil Class III (-10%)**
Decreased fertilization (kg/da)	-7.20	-2.4
Nmineralization (SOM) (N kg/da)	-1.00	-4.0
Residual N in the root zone (kg/da)	-2.00	-4.0
N input from irrigation (NO_3 content 10 mg/l)		
Nitrogen from irrigation with 500 (tn/da) (N g/m^3)	-1.13	-1.13
Leaching R=500 mm/y (kg N/da)	2.50	2.0
N input from rainfall (kg/y/da)	-0.50	-0.5
N_2O emissions kg/da	0.195	0.195
N_2 emission from denitrification kg/da)	1.68	1.68
Ammonia volatiliz. (10% of req. Nitrogen) kg/da)	2.40	2.40
N recommended (slope <6%) (kg N/da)	**18.9**	**18.1**

Table 8 RAINFALL REGIME 500 mm/year

CROP	Required nitrogen (kg/da)	Recommended N (kg/da) SOIL CLASS I	Recommended N (kg/da) SOIL CLASS II
Apple, pear trees	23.0	18.1	17.1
Corn	24.0	18.9	18.1
Potatoes	14.0	10.9	8.0
Sugarbeet	18.0	14.3	12.7
Tomato	20.0	16.1	14.9
Wheat	10.0	8.6	5.0

Table 9 RAINFALL REGIME 1500 mm/year

CROP	Required nitrogen (kg/da)	Recommended N (kg/da) SOIL CLASS I	Recommended N (kg/da) SOIL CLASS II
Apple, pear trees	23.0	19.3	18.2
Corn	24.0	20.1	19.2
Potatoes	14.0	11.8	9.0
Sugarbeet	18.0	15.1	13.5
Tomato	20.0	16.7	15.5
Wheat (rainfed)	10.0	9.4	5.9

Conclusions

-The recommended amount of nitrogen fertilization in both soil classes for dry and wet regions of Turkey varied significantly depending mainly on nitrates leaching.

-Nitrates leaching was higher around 5 kg/ha in the coarse soils in comparison to heavy soils.

-Nitrates leaching was also higher in the wet regions of Turkey.

-Best timing to apply N fertilizer is the period of rapid N uptake in order to minimize N leahing from the field, especially in wet regions (i.e. Black Sea).

-Irrigation methods, such as drip and sprinkler irrigation, assist to reduce deep percolation, which results to nitrates pollution of shallow aquifers.

-Decreased N fertilization can be applied without significant yield reduction and this can be explained by increased N use efficiency, as a result of proper time of application and splitting of N fertilizers in doses.

Acknowledgments

This work was carried out with financial support from the European Community through the National Programme for Turkey 2007 under the Instrument for Pre-Accession Assistance (IPA). This project entitled "Implementation of Nitrates Directive in Turkey" was implemented by Vakakis International S.A. (Greece) led consortium, in cooperation with authors.

THANK YOU VERY MUCH