Vegetal nutrition and fertilization: a new approach with organic fertilizers Eutrofit and Orgazot, with special focus on nitrogen use and activity

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1 - Introduction: concept of vegetal nutrition

Vegetal nutrition pass from roots as from leaves. Natural nutrition from leaves is shown in the hood by the action of rain with spattering of humid substances from soil to leaves.
Use of foliar fertilization is very important in agriculture in last years. Use of organic foliar fertilization have been studied by different researches with interesting results in order of increasing of plant fitness, sugar content, photosynthesis activity, setting of fruits, olives harvest etc. (Neri et al, 2001). Foliar nutrition and activity influence root activity by energy flux to the roots.
Root nutrition is interpretate by two ways: (a) conventional way of flux of elements and fertilizers; (b) organic and natural flux of elements, fertilizers and soil micro-organisms activity.
The conventional way of flux of elements and fertilizers use a computing of element removal by the harvest, fertilizer bringing and looses. In particular nitrogen fertilization have high looses of nitrogen in draining water, by evaporation, by micro-organisms use, denitrification and respiration.
The organic and natural flux of elements is the way of the nature, by using cooperation and symbiosis with soil micro-organisms. The activity of these micro organisms, for example nitrogen fixators and mycorrhiza (Harley and Smith, 1983), is usually depressed by high level of elements in soil solution (N, P, K, etc.). All this microbial activity arrives until changing pH of rhizosphere and so the nutrients availability and rocks solubility (Harley and Smith, 1983). Usually mycorrhizal symbiosis helps plants defences against pests (Bonfante and Giovannetti, 1980; Harley and Smith, 1983; Sir Howard, 1941). High level of nitrogen in the soil generates high mineralization of organic matter and, in the vegetal cells, expansion of cell volume decreasing cell wall thickness and increasing the sensibility to sickness. Nitrates in vegetables are also cancerogens.
The plant invests about 8% of photosynthesised energy out of the roots. This energy is available for micro-organism activity. For mycorrhiza the plant invest about 10% or more (about 20% of the total, Sylvia, 1998). This investment of energy gives back the availability of nutrients that is shown very well in a hood or in natural trees.
Why crops do not use the same way to have all the nutrients? Organic agriculture can use better this way, conventional agriculture can use in some way this organic cooperation by reducing fertilization and plant stimulation.

1.2 - Philosophy of fertilizers Eutrofit and Orgazot

Fertilizers Eutrofit and Orgazot are made according to this natural way of fertilization. They are made by animal blood sterilized at high temperature. Eutrofit is fluid, has 4% of Nitrogen and the form of organic matter is as peptides without free amino acids. It has about 500 ppm of natural Iron (Fe). Orgazot is solid, granular, and have 14% of Nitrogen in a form very slow release. Use of these fertilizers is in accord with IFOAM standards for organic agriculture (reg. CE 2092/91). They are also in Italian official list of organic fertilizers, that actually is the lonely list in Europe of fertilizers for organic agriculture checked by Italian Superior Institute for Plant

Nutrition (Istituto Superiore per la Nutrizione delle Piante, www.isnp.it), which has on line in the web site all the list admitted an not admitted fertilizers.

Experience with Orgazot is twenty years old and with Eutrofit about 15 years old. Recent experiences in Italy and Greece can be explained and gives the sense of this kind of fertilization.
Eutrofit is used such as “photosynthesis stimulator”, comporting increase in cell multiplication, in sap circulation, in roots activity and probably in microbial rhizosphere activity. Physiologic effects are continuously evaluated and studied in order to increase harvest quality and quantity of the crops.
Orgazot is just a slow release font of nutrients for roots and microbial communities of the soil, having stimulation effects on quantity and quality of harvest in low doses of nitrogen per hectare.
Both of them are used with success as in conventional agriculture as in organic agriculture.

1.3 - Computing of fertilizers and mineralization levels of organic matter in soil focusing on nitrogen

Nitrogen in soil is available, in common agronomic concept, by mineralization of organic matter. The availability of nitrogen for a crop therefore depends from level of organic matter in soil (%), which is in function of soil density (around 1 ton/m3, depending on texture), and C/N relation (around 10 in stable soil). Rate of mineralization range is from 5% to 1% of the organic matter per year, depending on factors like kind and level of soil tillage, irrigation, fertilizers, climate, etc. (Zucconi, 1996; Regione Marche, 2001).

Tab 1. Hypothetical mineralization of nitrogen in field per year

% Of organic matter in soil	Total tons/ha organic matter in 30 cm dept/ha	Tons/ha of nitro-gen	Mineralization 2%	kg N/ha per year mineral-ized
3	90	4,5	0,09	90
2	60	3	0,06	60
1	30	1,5	0,03	30

Example considering organic matter in soil in first 30 cm dept, soil density of 1 ton/m3, C/N 10 (about 50% C in organic matter and 5% of total nitrogen in organic matter).

Manuals of agriculture usually make a simplification of the problem and indicate the needs of nitrogen for crop depending on forecast harvest. This is, in a certain sense, right because the cycle of the element does not think about what is inside the soil, but what will be extracted, looking the removal of element and giving the same quantity in fertilizer. The quantity of fertilizer will be usually higher than needs because of looses of elements by insolublization and drainage by water.
In the reality soil activity and its availability of elements is rarely computed. Nitrogen availability by mineralization do not enter the computing. The idea of increasing soil activity in term of nitrogen fixation by symbiosis and not remain inside the university but rarely arrives to the field.
Nitrogen fertilizers have a big problem of high solubility and loose by water during rain or

irrigation and denitrification activity of micro-organisms.
Looses in water are responsible to the water pollution and nitrates in drinking water are responsible of stomach cancer.

2 - Material and methods

Some of the experiments and experiences of these fertilizers of last two years will be presented showing the use fertilization elements in comparison with conventional concept of mineral fertilization on tomato, potato, olive and wheat. No data of soil analysis are available, both mineral and microbial activity. The removals of nitrogen and other elements are made in accord to the Italian manual of good agronomical practice (Manuale di buona pratica agricola, misura F1 e F2, Piano di sviluppo Rurale della Regione Marche, 2001). Other help about nitrogen fertilization concept is from a Greek manual of fertilization (Theodorou and Paschalidis, 1999).
The concept is how these organic fertilizers change the common computing of nitrogen fertilization, comparing common computing and results with introducing of Eutrofit and Orgazot.
Content of nitrogen in harvest was computed using the minimum indicated in manuals.

3 - Experiments and experiences

3.1 - Tomato for industry

A trial on industrial tomato has been performed in conventional agriculture in a farm in Larissa area. The trial has been done on two hybrids of tomato using spray of Eutrofit before transplantation and during the cultivation in field.
The setting out and the results are as following.
List of fertilizers:
Basic fertilizer:
Urea (46N) 165 kg/ha - 0-0-50 (50 K2O) 70 kg/ha
In drip fertilization:
Ammonium Nitrate (34N) 180 kg/ha
20-20-20 - 50 kg/ha
15-5-0 + 19 Ca - 30 kg/ha
Calcium Nitrate (21N) - 30 kg/ha
Potassium Nitrate (13-0-44) 50 kg/ha
Eutrofit (4N) 25 kg/ha (in two experimental plots)

Tab. 2 - Nitrogen use and fruit harvest in industrial tomato

	Hybrid 1	**Hybrid 1 with Eutrofit**	**Hybrid 2**	**Hybrid 2 with Eutrofit**
Urea (46N) 165 kg/ha	75,9	75,9	75,9	75,9
Ammonium Nitrate (34N) 180 kg/ha	61,2	61,2	61,2	61,2
20-20-20: 50 kg/ha	10,0	10,0	10,0	10,0
15-5-0 + 19 Ca : 30 kg/ha	4,5	4,5	4,5	4,5
Calcium Nitrate (21N): 30 kg/ha	6,3	6,3	6,3	6,3
Potassium Nitrate (13-0-44): 50 kg/ha	6,5	6,5	6,5	6,5
Eutrofit(4N): 25 kg/ha		1		1
Total Kg of Nitrogen/ha	149,9	150,9	149,9	150,9
Harvest ton/ha	**68,0**	**97,0**	**75,0**	**130,0**
% Of more harvest		42,6		73,3
Kg of Nitrogen/ton of tomato	2,2	1,5	2,0	1,2
% Of use of Nitrogen/ton of tomato		*-29,9*		*-42,3*
Nitrogen removal from tomato (2,5 kg/ton, as agricultural manuals) kg	170,0	242,5	187,5	325,0
Difference with Nitrogen in fertilizers (fertilization – removed) kg	-20,1	-91,6	-37,6	-174,9
% Of difference from removal	*-13,4*	*-61,7*	*-25,1*	*-116,7*

Industry did not see differences about Brix degree (4,4 for firs hybrid and 5,0 for second hybrid) with and without Eutrofit. In personal measurements there was a difference about 0,5 Brix more in treated with Eutrofit.

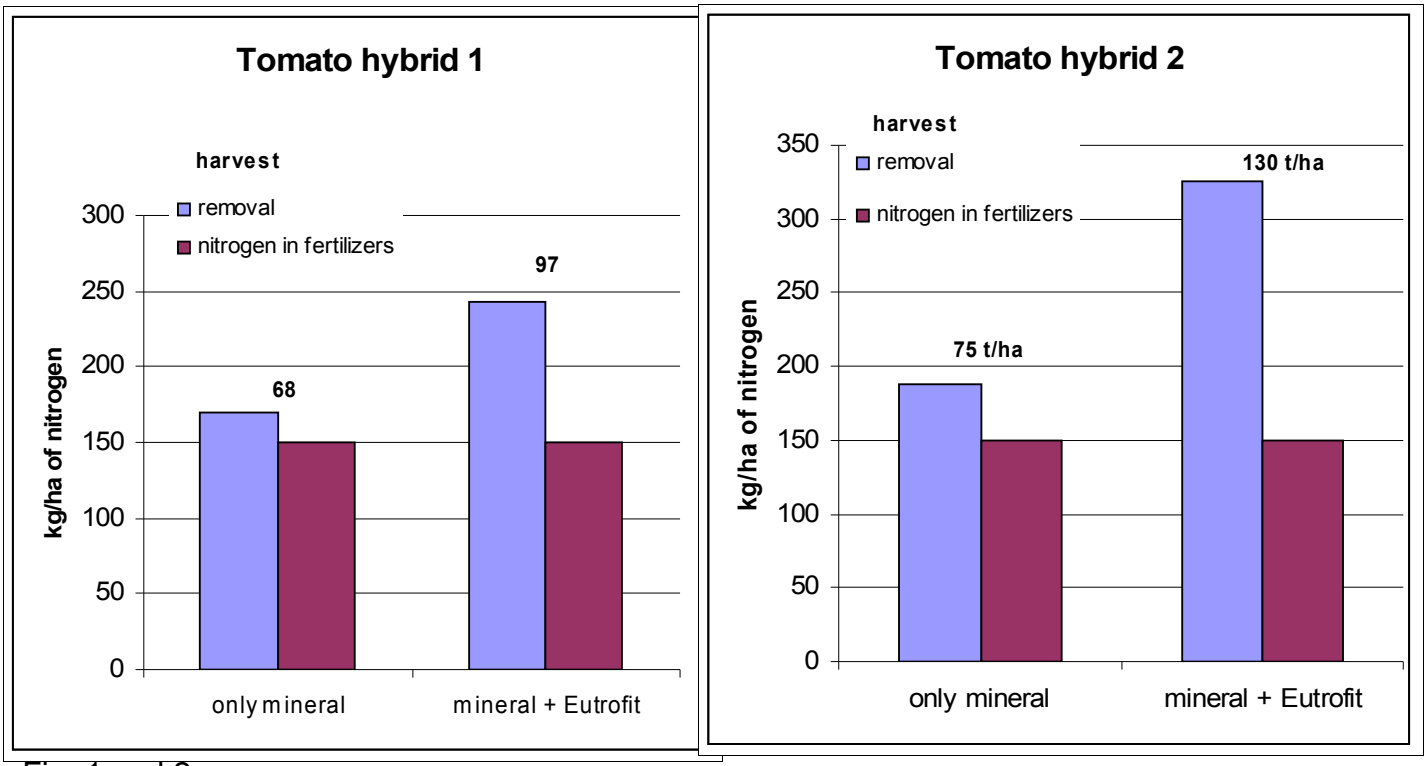


Fig. 1 and 2

3.2 - Potato

Some experiences and experiments have been realized on some varieties of potato from potato seeds of the Association Producers of Potatoes of Montagnana (APPA, Padova, Italy) and with the help of the same Association.

3.2.1 - Potato CV Agata and Primura

On varieties Agata and Primura have been done compared two plots:
Plot 1 - low Eutrofit leaf fertilizer (10 kg/ha) and common mineral fertilization;
Plot 2 – higher Eutrofit leaf fertilizer (30 kg/ha, as label), Orgazot microgranulato (in small grains) in raw at sowing (21 kg/ha) and common mineral fertilization.

Fertilizers distributed:
Basic fertilization before sowing: 900 kg/ha of 8-24-24
Orgazot microgranulato in raw during sowing: 21 kg/ha (only plot 2).
During weeding fertilized with Ammonium Sulphate: 500 kg/ha
Eutrofit sprayed mixed with pesticides:
plot 1: 2 treatments with 5 kg/ha
plot 2:6 treatments with 5 kg/ha.

Tab. 3 – Effect of introduction of Orgazot in sowing (21 kg/ha) and a dose as label of Eutrofit (30 kg/ha total, in place of 10 kg/ha of the first thesis).

	Plot 1 (without Orgazot and low Eutrofit)	**Plot 2 (with Orgazot in sowing and more Eutrofit)**	***increase %***
kg. of nitrogen in 900 kg of 8-24-24	72	72	
Kg. of nitrogen in 21 kg of Orgazot	0	2,9	
Kg. of nitrogen in Ammonium sulphate	105	105	
Kg of nitrogen in 10 and 30 kg of Eutrofit	0,4	1,2	
Total nitrogen in fertilization	177,4 kg.	181,1 kg	***+ 2%***
Harvest CV Agata	43 t.	50 t.	***16%***
Harvest CV Primura	44 t.	55 t.	***+ 25%***

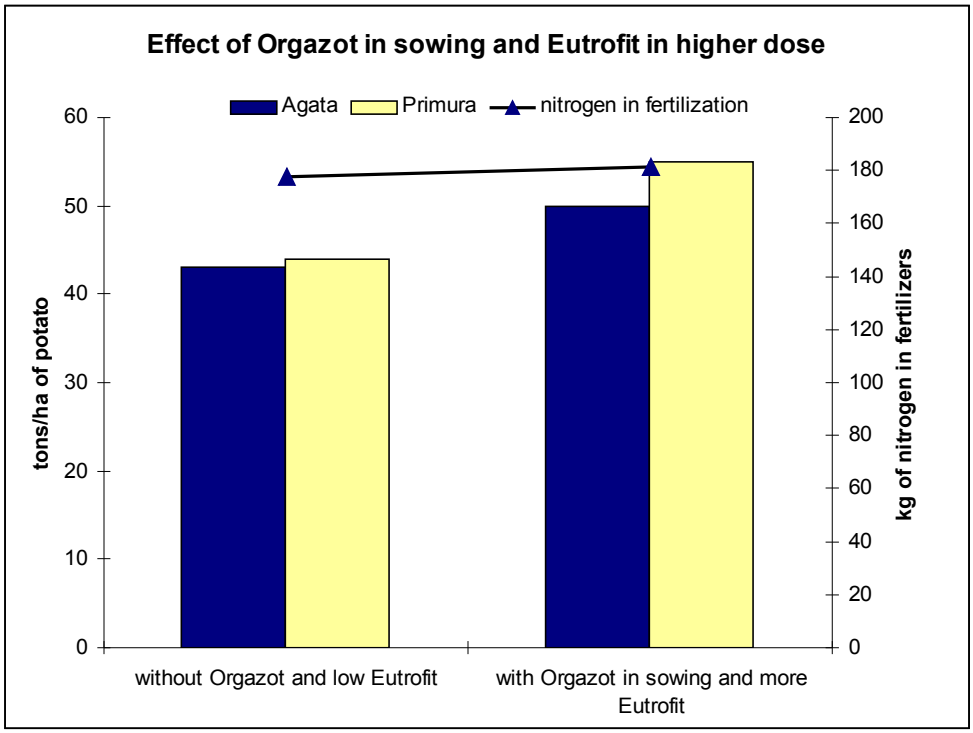
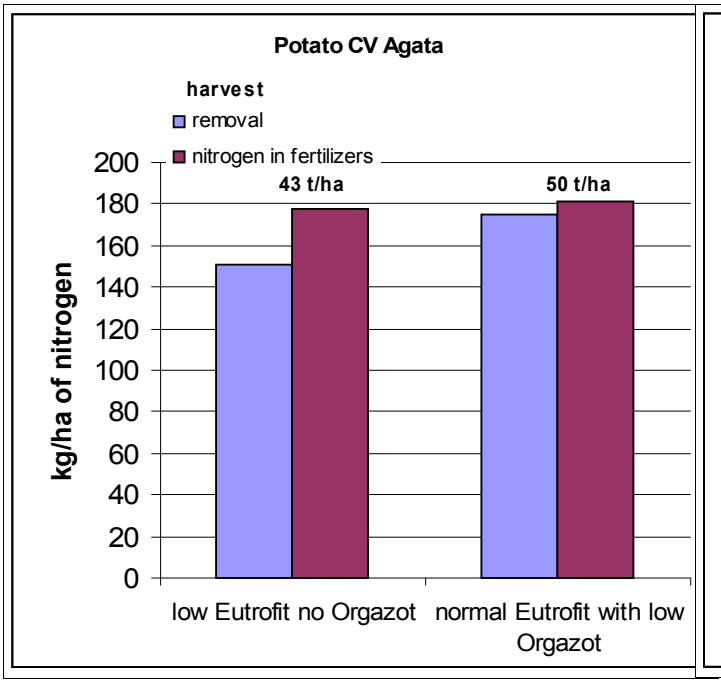


Fig. 3 – The picture show as the varieties Agata and Primura with the introduction of Orgazot in sowing (21 kg/ha) and a dose as label of Eutrofit (30 kg/ha total, in place of 10 kg/ha of the first thesis) consent a high performance of the potato harvest with very low increase of nitrogen in fertilization.



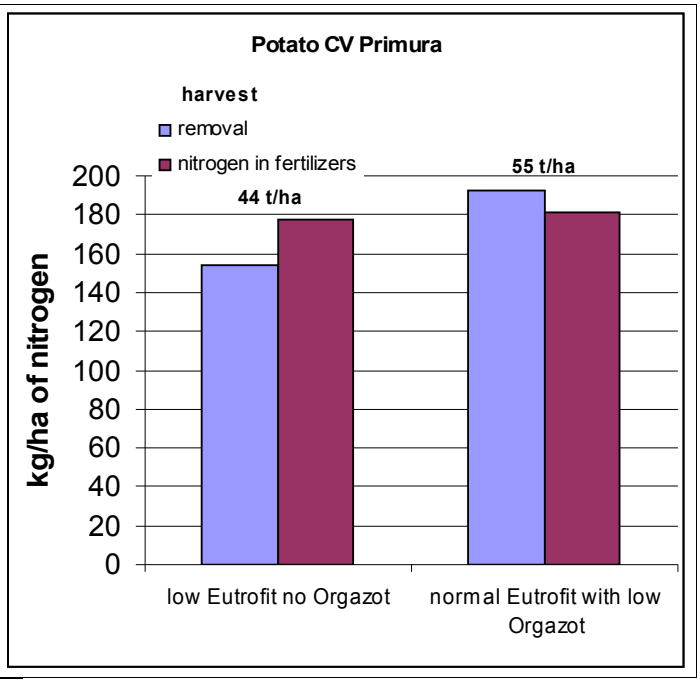


Fig. 4 and 5

3.2.2 - Potato CV. Vivaldi

On variety Vivaldi was made a more significative test on effect of Orgazot microgranulato in raw during sowing (20 or 30 kg/ha) and Orgazot granulato in substitution of ammonium sulphate at weeding.

Table 4 of treatments and results on potato Vivaldi

	Thesis 1	**Thesis 2**	**Thesis 3**
Basic fertilizer	900 kg/ha 8-24-24	900 kg/ha 8-24-24	900 kg/ha 8-24-24
In raw during sowing	----------	**Kg 30/ha** Orgazot microgranulato	**Kg. 20/ha** Orgazot microgranulato
Weeding	**500 kg/ha Ammonium Sulphate**	**300 kg/ha Ammonium sulphate**	**200 kg /ha Orgazot granulato**
Spray with pesticides	30 kg/ha Eutrofit total (divided in 6 spray)	30 kg/ha Eutrofit total (divided in 6 spray)	30 kg/ha Eutrofit total (divided in 6 spray)
Results: harvest in tubers	47 tons/ha	52 tons/ha	60 tons/ha
Increase %	0	+ 10 %	+ 27 %
Increase % (Orgazot -Ammonium sulphate)	////	0	+ 15 %

Table 5 of use of Nitrogen of fertilization and its efficiency

Fertilizer source of Nitrogen	**Thesis 1**	**Thesis 2**	**Thesis 3**
8-24-24	72	72	72
Orgazot		4,2	2,8
Ammonium sulphate	105	63	
Orgazot granulato			28
Eutrofit	1,2	1,2	1,2
Total N	**178,2**	**140,4**	**104**
Tons/ha of tubers	***47***	***52***	***60***
% increase of harvest (thesis 3 =0)	0	+10,6	+27,6
% increase of harvest (thesis 2 =0)	//////////////////////	0	+15,3
kg N/ton potato	**3,79**	**2,7**	**1,73**
kg potato/kg N	263	370	576
Efficiency (%) of nitrogen in fertilization (Thesis 3 = 100)	100	140	218
Decrease of use of nitrogen kg./ha (thesis 3 = 0)	0	-37	-74
% decrease of use of nitrogen	0	-21,2	-41,6

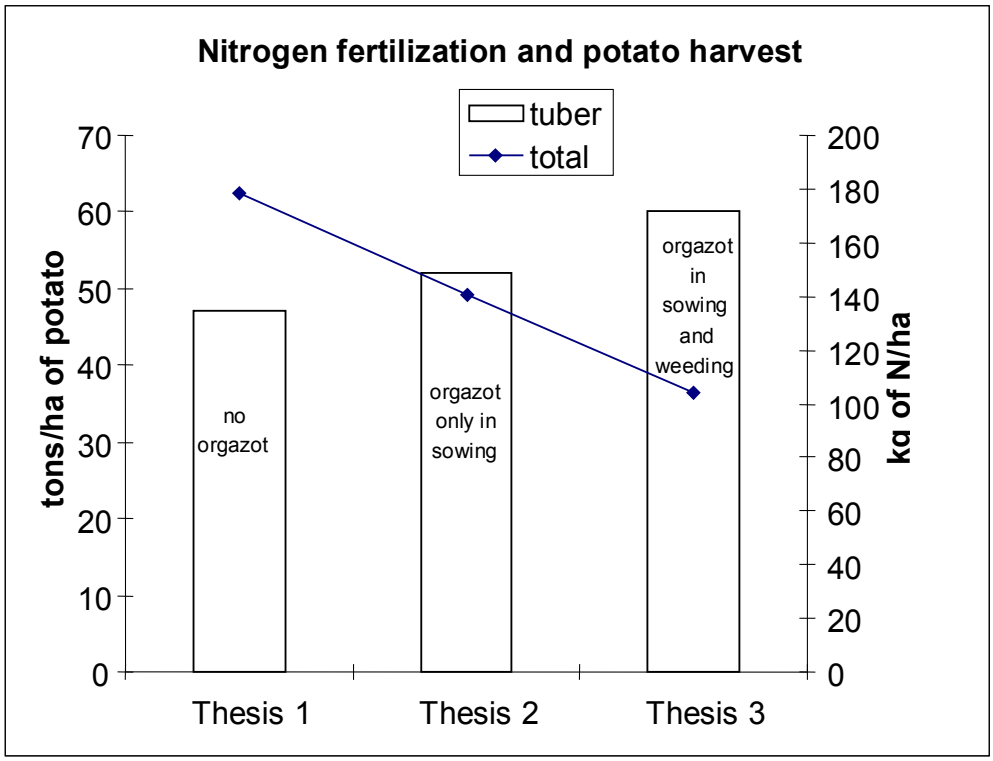


Fig. 7 – Harvest of potato and nitrogen fertilization: with Orgazot (thesis 3 and 2) less units of nitrogen are given and more tons of potato is harvested.

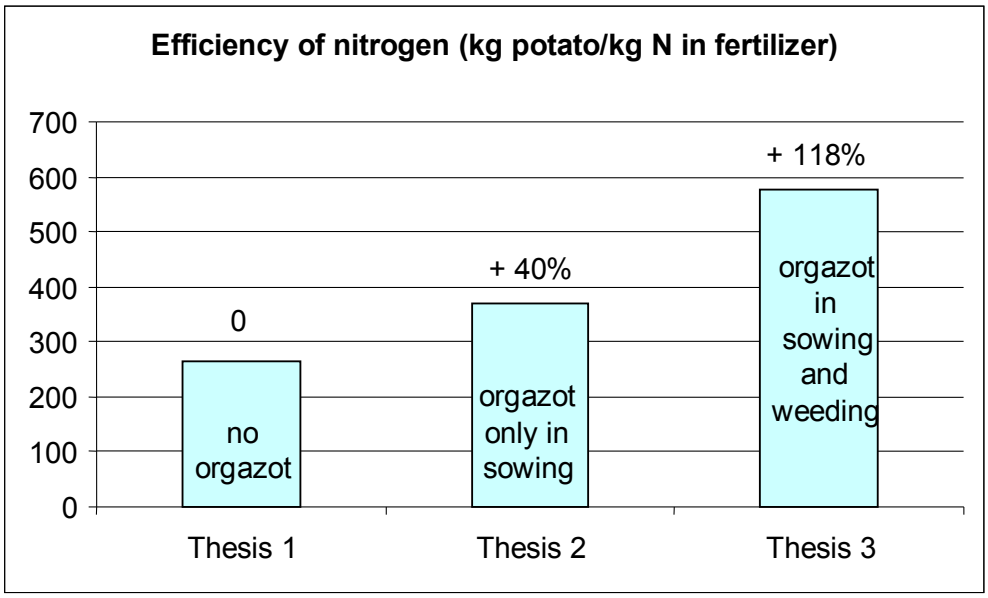


Fig. 8 - Effect of each kg of Nitrogen from fertilizers on harvest of potato: the efficiency increases very much increasing use of Orgazot (thesis 3).

Table 6 - Content of nitrogen in tubers and its differences with fertilized nitrogen (differences in negative are quantities of nitrogen that the manual cannot explain if it makes the hypothesis that a content of 3,5 kg/ton tubers is the minimum content)

	Thesis 1	Thesis 2	Thesis 3
Kg. /ha of nitrogen	178,2	140,4	104
Hypothetical content of nitrogen in tubers (3,5 kg/ton)	164,5	182	210
Differences (kg. N/ha)	13,7	-41,6	-106
% Of differences	7	-29	-101
Minimum use of nitrogen considered in Italian manual of reduction of fertilizers	164,5	182	210
Maximum use of nitrogen considered in Italian manual of reduction of fertilizers	235	260	300
Use of nitrogen considered in Greek agricultural manual	235	260	300
Hypothetical content (kg N/ton potato) of nitrogen in potato (looses = 0)	3,79	2,70	1,73
Comparison %	100	-28	-54

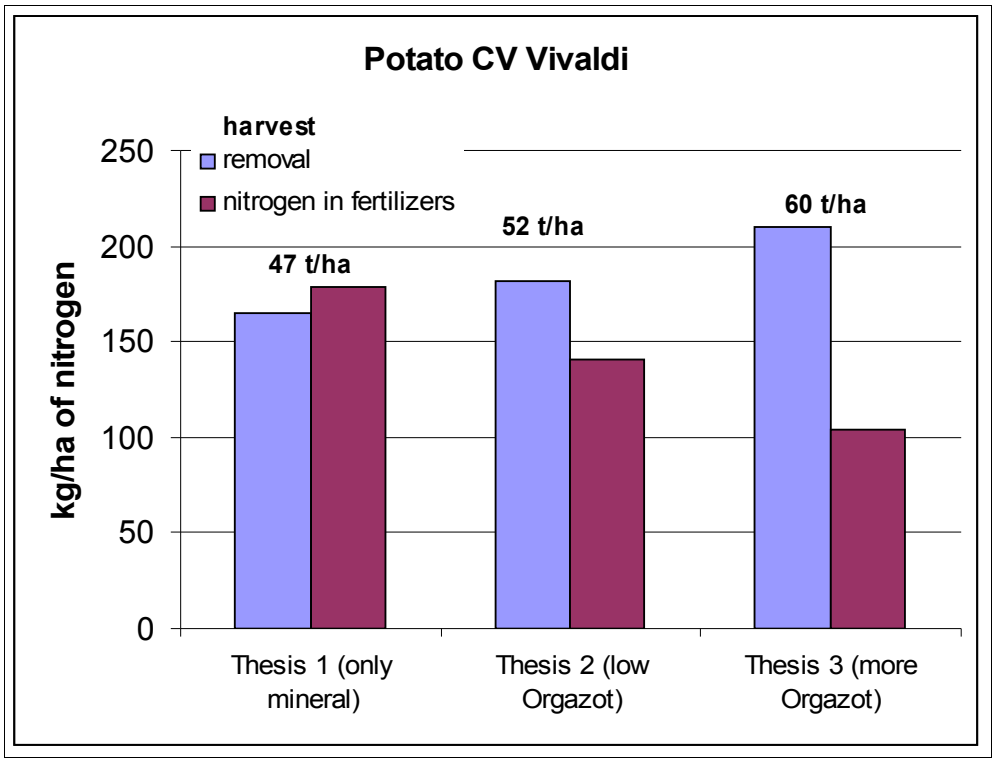


Fig. 9

First of all the high activity of the organic nitrogen of Orgazot and the very useful moment of fertilization in raw during sowing with a very low dose of fertilizer: it makes very high effects on harvest (+ 10% in Vivaldi) even with a reduction of ammonium sulphate (40 % less).
Association of label dose of Eutrofit (30 kg/ha) and introduction of Orgazot in raw at sowing (21 kg/ha) makes higher effects on harvest (+16% in Agata and +25% in Primura).
Substitution of ammonium sulphate (500 kg/ha = 105 kg N) with low quantity of Orgazot (200 kg/ha = 38 kg N) during weeding gives a very good increase of harvest (15 % more than thesis 2 with Orgazot at sowing and 27 % more than thesis 1 (only mineral fertilizers)).

3.3 - Olive

Experiment in conventional agriculture in farm Dimitsis Tsomeltsoglou in Olintho, Halkidiki, Greece.

The experiment was onset in one hectare olive orchard and it was divided in three plots changing spring fertilization:
1 – Urea 250 kg/ha
2 – Urea 250 kg/ha + spray Eutrofit 20 kg/ha (divided in 4 times)
3 – Orgazot 162 kg/ha + spray Eutrofit 20 kg/ha (divided in 4 times)

Winter fertilization for all the field (and plots) was:
21 0 0 + 24 S (Ammonium Sulphate) – 750 kg/ha
0 0 30 + 18 Mg - 750 kg/ha
Iron Sulphate - 125 kg/ha
0 0 0 (S) 18 (Sulphur) - 70 kg/ha

Tab 7

	Urea	Eutrofit + Urea	Eutr.+ **Orgaz.**
21 0 0 24: 3 kg/tree	0,63	0,63	0,63
Urea (46N): 1 kg/tree	0,46	0,46	
Orgazot (14N): 0,65 kg/tree			0,09
Eutrofit (4N): 0,02 kg/tree			
Kg of Nitrogen/tree	1,09	1,0932	0,721
Kg of N/ha (250 trees/ha)	**272,5**	**273,3**	**180,25**
Olives harvest tons/ha	**8,22**	**13,16**	**11,51**
More harvest % than only urea		**+ 60%**	**+ 40%**
Kg of Nitrogen/ton of olives	**33,15**	**20,77**	**15,66**
Efficiency of nitrogen			
Kg of olives/kg of Nitrogen	30	48	63
%	100	159	211
% more than only urea		**+ 59%**	**+ 111 %**

Tab. 8

	Urea	Urea + Eutrofit	Eutrofit + Orgazot
Olives harvest tons/ha	8,22	13,16	11,51
Nitrogen necessary for this harvest by **Italian manual** agriculture for areas with nitrates emergency (36,6 kg N/ton olives)	301,4	482,5	422
Nitrogen necessary for this harvest by **Greek manual** of agriculture (1 kg/tree*year of N)	250	250	250
Real fertilization	**272,5**	**273,3**	**180,25**
Difference (manual – real fertilization) % of Italian manual	. +10,6%	. +76,6%	. +134,1%
Difference (manual – real fertilization) % of Greek manual	-8,3%	-8,5%	+38,7%

Increase of harvest did not decreased the dimension of the olives (quality parameter for table olives) remaining on 130 pieces/kg.
Increase of harvest was affected first of all to the higher number of fruits per tree in the treated plots.

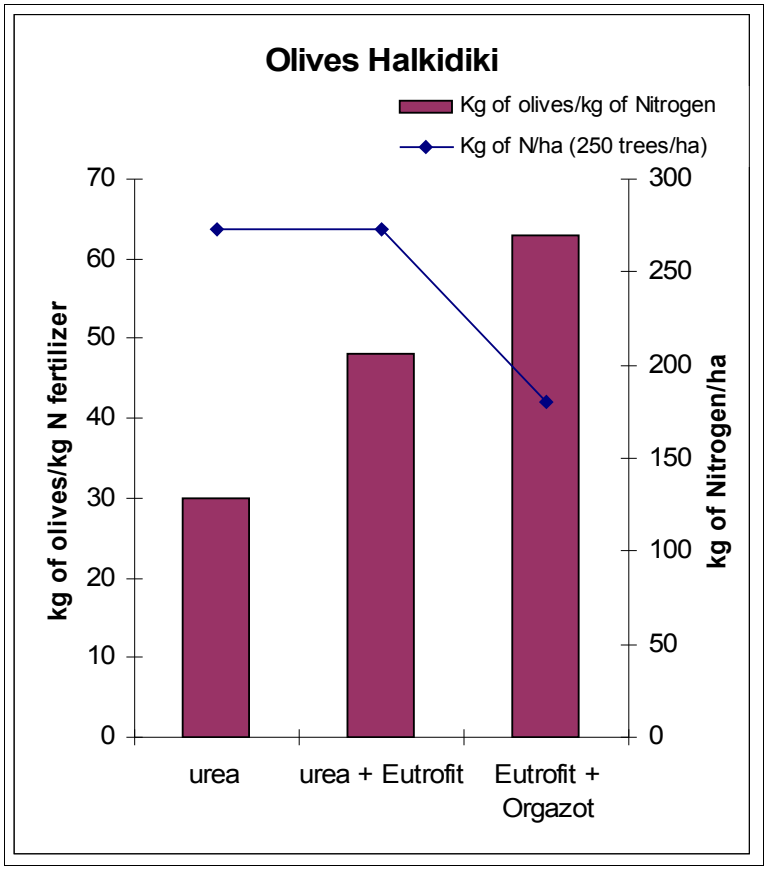


Fig. 10

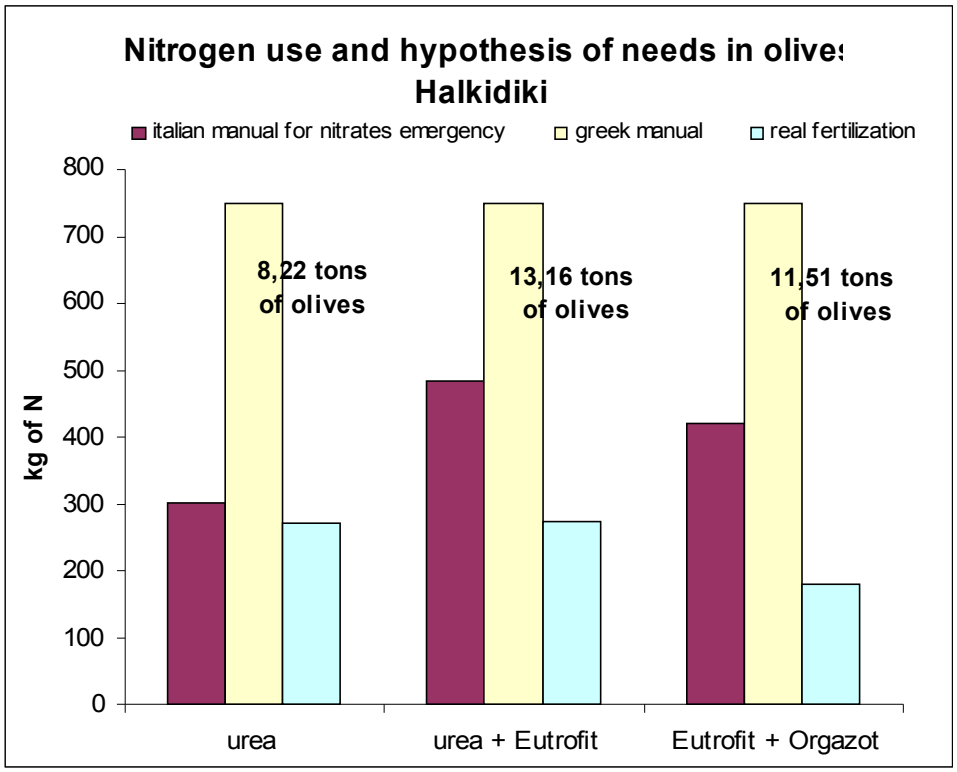


Fig. 11

Fig. 12 – Left leaves fertilized only with mineral, central leaves Orgazot + Eutrofit in substitution of urea, right leaves mineral + Eutrofit. Is evident how spray with Eutrofit had a pathology effect decreasing the influence of *Spilogea oleagina* (leaves circle fungi; see photo 12). In the end of the season (September) the effect was evident also on acars, which didn't reach damage level in Eutrofit sprayed area.

3.4 - Wheat

3.4.1 - Experience in conventional agricultural

Farm Papahatzis Georgios, Larissa, Greece. Crop of durum wheat (Triticum durum), CV Simeto. The farm does not make rotation with Leguminoseae

Tab 9

	Without	With Eutrofit
Fertilizer		
20-10-0 + 12% S - 300 kg/ha	60	60
Eutrofit 4N - 10 kg/ha		0,4
Total N/ha	**60**	**60,4**
Harvest ton/ha of grains	3,33	4,07
More harvest with Eutrofit		. + 22,2 %
Nitrogen removal (kg/ha)		
Grains	73,4	89,6
Raw	10,2	10,3
Total	**83,6**	**99,9**
Kg of difference (fertilizer - removal)	-23,6	-39,5
%	-39,33%	-65,39%

The seed was coated by Eutrofit
Proteins content was not affected by the higher production. Mean weight of grains was about 10% more in treated with Eutrofit.

Nitrogen removation: grain (22 kg N/ton of grain) + raw (0,3 kg N/ton of grain)

Tab 10 - Farm Ca' Venier, Reggio Emilia, Italy. Cultivation of soft wheat (Triticum aestivum) CV Guadalupe

Fertilizer	Kg.	N
8-24-24	400	35,2
Urea (46 N)	160	73,6
Orgazot 14N	**20**	**2,8**
Eutrofit 4 N	10	**0,4**
	Total	112
Removal		N
Grains	7500	142,5
Raw	4000	12
Total		**154,5**
	Kg of difference (fertilizer - removal)	- 42,5 kg.
	%	-38,00%

Nitrogen removal: 22 kg N/ton of grain + raw (0,3 kg N/ton of grain)
Content of proteins did not change between treated and not treated with Eutroft.
The seed was coated by Eutrofit.

3.4.2 - Experience in organic farming:

Tab 11 - Farm Ciavattini Gianfranco, Maiolo (PU), Italy. Soft wheat (Triticum aestivum) var. Nobel, at the third year of cereals in crop rotation

	With Eutrofit spray
Fertilizer	
No basic fertilizer	0
Eutrofit 4N - 6 kg/ha	0,24
Total kg of N/ha	**0,24**
Harvest ton/ha of grains	**3,5**
Mean harvest of cereals of the area on 2003	1,5
Nitrogen removal (kg/ha)	
Grains	77
Raw	10,5
Total	**87,5**
Kg of difference (fertilizer - removal)	-87,26
% of nitrogen not from fertilization	99,7%

Nitrogen removal: grain (22 kg N/ton of grain) + raw (0,3 kg N/ton of grain)
The harvest of a part not treated was near to zero.

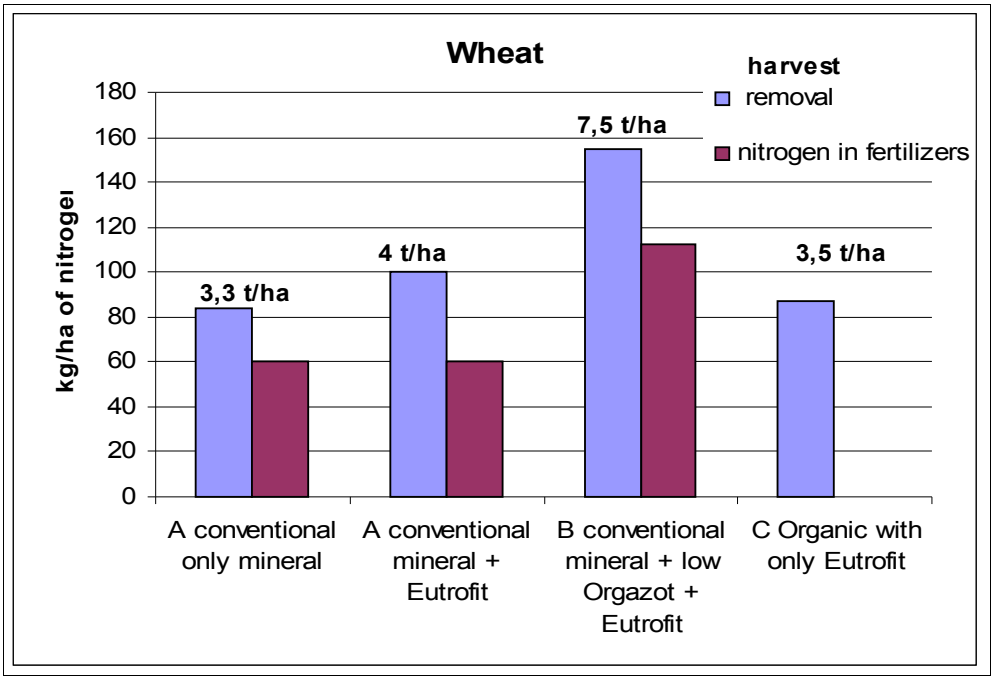


Fig. 12

Fig. 13

Fig. 14

Fig. 15

Fig. 13 –14 -15 – Organic soft wheat (Triticum aestivum) fertilized only with 6 kg/ha of Eutrofit. Is evident the different dimension and pathology effects: spray of Eutrofit decreased the influence of wheat rust (*Puccinia* spp.; see photos)

4 - Comments and conclusions

Use of Eutrofit and Orgazot generally gives an increase of production increasing nitrogen activity in terms of kg of nitrogen per ton of harvest.
Usually this comports an increase of quality and shelf life of the production because of the less concentration on nitrates in the cells.
Effect against pathogens is usually high, probably due to the increase of photosynthesis, cell wall thickness, vegetal defence substances inducing decrease of plant pathogen sensibility.
Economic results are usually good, obviously higher in fruits and vegetables (potato, tomato, olive, etc).
The classical theory of fertilization based on “removal” and “contribution” of elements, computed with theoretical looses, do not find cofirmation when we use organic fertilizers and stimulators, as demonstrated with Orgazot and Eutrofit. Their effect on plant physiology activation and root-rhizosphere stimulation is something that is usually not computed in conventional fertilization.

Probably the investment of energy (roots and sugars) in the roots and rhizosphere is very higher using these fertilizers and can find sources (as rocks, di- and tri-calcium phosphates, for example, potassium from silk, not symbiotic azoto bacters? etc.) that are usually not available. Organic matter mineralization is not sufficient to explain the results because of is expected more mineralization using more nitrogen and in mineral form, causing rapid increase or dead of micro-organisms (Zucconi, 1996).

These experiences create the necessity to have a new approach to fertilization, which is friendlier with soil and not “exact” as it seems with mathematical computing of fertilization element. This is a systemic approach that tries to use the activation of soil biological sources and crop physiologic activity inducing high performances in crops and soil life and fertility increase. Soil fertility increase is due to the higher level of organic residues obtained with this kind of fertilization and lower soluble elements in circulation water in the soil, which is known as depressive to the mycorrhizal activity.

In general the use of these fertilizers gave the following advantages:
1 – increase of harvest (+ 10% until 60% depending on crops and treatments)
2 – decrease of use of nitrogen (until 74 %, or 99% for organic experiment on wheat)
3 – increase of activity of all the elements (P, K, etc.) due to the higher production by the same fertilizers.
4 – higher quality and shelf life conservation of the products due to the lower content in nitrogen of the vegetal cells.
5 – high performances with fertilizers admitted in organic agriculture (from 263 to 576 kg of potato per kg. of nitrogen fertilized = +118%), consenting evolution of organic crop performances.
6 – low impact on environment thanks to the lower quantity of nitrogen, the more natural form of it and the slow release kind that consent to the crop to absorb the element reducing pollutant looses.
7 – good economical results thanks the high relative result (+10 until + 60% depending on treatments) and the low cost of the treatments.

Next step is to find and demonstrate a completely organic strategy of fertilization to get similar or better result than conventional with economical and ecological higher result.
Than will be the moment to make new theoretical models of fertilization.
Actually we can affirm that the introducing of low quantities of organic fertilizers with low nitrogen contribute, well studied, can help both conventional and organic agriculture to reach a new level of quality and harvest.

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