THE ISSUE OF SOIL ACIDIFICATION UNDER ORGANIC FARMING PRACTICES: A CRITICAL VIEW

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Abstract. *An agrochemical assessment of the soils fertility under organic farming practices has been performed in The Research and Development Station for Vegetable Growing in Bacău. Fertility parameters, including soil pH, varied very little along the fifteen years of organic trials. The results oppose other findings recently published on an investigation carried in Romania revealing that soil acidification is a reality of organic farming. There are plenty of important papers that give a better insight of the effect that certified organic practices have on soils. Yet, the advocates of soil acidification induced by organic farming practices have used references that cannot back the conclusion that soil acidification is a common pattern in organic farming. Generalizing that organic farming leads to soil acidification does not make sense. Moreover, the statement made that it makes scientific and practical sense to use the pH as indicator of organic management of the soils is based on local findings only and should not be considered as a reliable proposal. The present paper findings stands for the already recognized environmental benefits of the organic farming carried under a proper management.*

Key words: *soil, pH, acidification, organic farming.*

INTRODUCTION

Strongly influencing the availability of plant nutrients and thus indirectly regulating the biomass production as well as affecting the organisms found within the soil, the soil acidity is among the important environmental factors which can influence plant growth and crop yields. Soil pH should be the first soil parameter to be checked when attempting to grow a plant, regardless the plant is conventionally or organically grown. The soil pH depends much on the soil parent material and the weathering processes formerly and presently acting "on site" (climate, topography vegetation etc) which may tend in some circumstances to cause a decrease of soil pH over time. However, the agricultural practices undertaken my also contribute to an intensified acidification process. Whether in few years is overlooked, soil acidity can seriously limit crop production.

Often considered to be the "master variable" of soil (HAMZA, 2008), the soil pH is measured by a routine analysis conducted on almost any soil sample submitted to a soil testing laboratory. Therefore, organic farmers, alike the conventional ones, are encouraged by both advisers and certification inspectors to check periodically the level of soil pH. Moreover, in many cases, organic systems require more intensive soil sampling than conventional systems, since they often have a greater diversity of crops and rotations (PHILLIPS, 2014). As the matter of soil acidity is assumed to be part of the basic knowledge for organic farmers (in the same extent as for the conventional farmers), most of recent research testing the soil fertility in organic farming did not focus entirely on the single issue as soil pH variability but rather on a much broader and complex approach of the soil environment (including pH, among many other soil indicators).

Most surprisingly, a recently released paper on some investigation carried in Romania revealed that soil acidification is a reality of organic farming (TONCEA et al., 2015). The studies were carried in the organic fields of two Romanian agriculture research units located in the Romanian Plain ecosystem. The authors concluded that it makes scientific and practical sense to use the pH as indicator of organic management of the soils, because pH represents a central position in chemical and biological processes of the soil and plant growth, and pH measurement is neither difficult nor expensive. With these unexpected outcomes issued by a research team led by a Romanian high profile organic farming expert (and a power broker for the Romanian organic sector), the claimed beneficial environmental impact of the organic production system in Romania (ŞTEFĂNESCU et al., 2015) as well as the organic farming generally recognized positive contribution to the deliverance of public goods (COOPER et al., 2009), seem to be cornered. Anyway, investigation carried in the oldest Romanian certified organic farming experimental field (LUNGU et al., 2009), provides a complete different picture on the issue. Exclusively organic fertilization, with compost and/or green manure for over 15 years at the Research-Development Station for Vegetable Growing in Bacău, Romania, maintains a relatively stable level of soil fertility properties.

In fact, the opposed results concerns the two (and only) longest organic farming trials in Romania: the Assistance Centre for Organic Agriculture, belonging to the highly reputed National Agriculture Research and Development Institute (NARDI) Fundulea-Călăraşi, in which the decrease of soil pH is reported and the oldest certified organic trail in Research-Development Station for Vegetable Growing Bacău that shows no changes of the soil pH under organic farming). Nevertheless it should be noted that, when comparing results from different locations, each of the implemented farming system may have different geographical, climatic and soil characteristics, different crops, different rotation systems (both in crop species and timing) and different sort of inputs (GOMIERO et al., 2011).

MATERIAL AND METHODS

The Research and Development Station for Vegetable Growing Bacău was set on September 1st 1974, in the circumstances of the implementation of the program for self-sufficiency and development of modern and efficient vegetable growing in the Eastern area (Moldavia). It is located in the Eastern part of the Bacău City, in the meadow and on the first Siret River terrace, at 91 m altitude. The soil is a Fluvisol, with a sandy-loamy texture, ranging between 6.2 - 6.8 pH, and 1.4 to 1.5% organic carbon content. The average multi annual temperature is 8.9°C and the average annual rainfall amounts 550 mm.

Two experiments were carried out. In one of them the same plot was sampled and analyses have been performed in five of the fifteen years after the land was organically certified (1992-2007).

In the other, on a 7.3 ha experimental field, 20 equally sized plots were delimited for sampling, in April and October 2006. Vegetables were grown in both experiments and fertilization was exclusively organic, with vegetal farm compost, resulted from the aerobe fermentation of the vegetal residues.

Agrochemical parameters were determined in the samples, using standard methods: pH, potentiometrically; organic matter (OM), by the Walkley-Balck method, modified by GOGOAŞĂ; total nitrogen, by Kjeldahl method; mobile phosphorus and potassium, soluble in ammonium acetate-lactate. Soil reaction (pH) was determined in soil samples that were air dried, grounded, and passed through the 2 mm sieve potentiometrically, in aqueous suspension, 1/2.5 ratio, 2 h time of contact, with a double glass and calomel electrode (compliant with the Romanian Standard SR 7184/13-2001, Soils, pH determination in aqueous and saline suspensions-mass/volume and in saturated paste).

The references cited by the article highlighting the issue of soil acidification under organic farming practices were checked, for the fair understanding of their relevance.

RESULTS AND DISCUSSIONS

Fertility parameters varied very little along the fifteen years of organic trials in the Research and Development Station for Vegetable Growing Bacău (Table 1). As compared to the average values, the differences are very small (± 10% margin). The soil pH is slightly acid (RISSA, 1987).

Table 1

Evolution of the fertility parameters of the soil under organically vegetable growing, over a 15 years period

Year	pH	OM %	Total N %	C:N	Mobile P mg/kg	Mobile K mg/kg
1992	6,50	2,7	0,12	10,5	80	180
1995	6,50	2,6	0,16	9,3	97	185
2000	6,65	2,6	0,14	12,1	115	180
2005	6,25	2,4	0,12	11,5	69	140
2007	6,67	2,3	0,12	11,2	89	195
Average	6,51	2,52	0,13	10,92	90	176

No significant variations can be noticed over the growing season (tables 2 and 3) meaning that fertilization with farm compost fairly maintains the soil fertility properties. The pH variations along the 15 years are within the precision margin of the analyses performed by the National Research and Development Institute for Soil Science, Agro-Chemistry and Environment-ICPA Bucharest (RISSA, 1987) (figure 1).

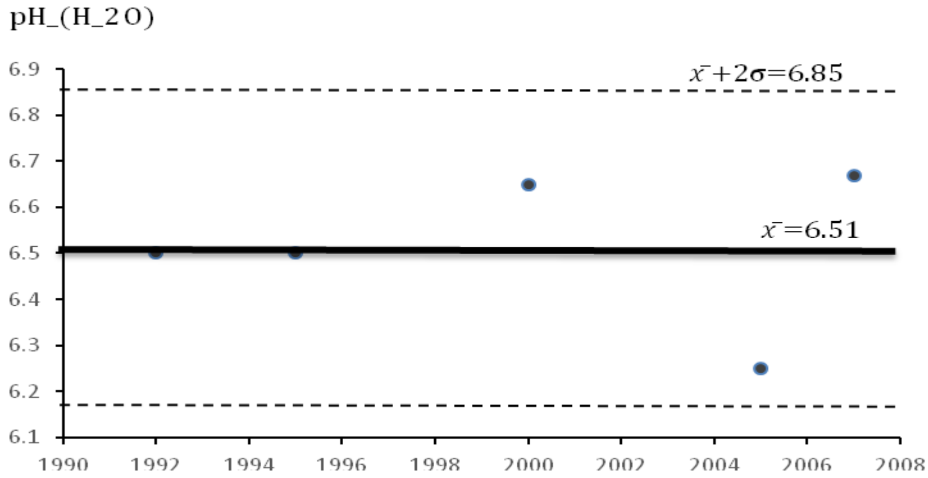

Fig. 1: Soil pH evolution under organically vegetable growing, over a 15 years period

Table 2

Statistical parameters of the fertility properties of the soil sampled in April 2006

Statistical parameter	pH	OM %	Total N %	C:N	Mobile P mg/kg	Mobile K mg/kg
x_{min}	6.11	1.69	0.087	10.9	42	140
x_{max}	7.18	3.15	0.158	12.5	160	265
$\bar{x}$	6.59	2.34	0.117	11.5	89	191

Table 3

Statistical parameters of the fertility properties of the soil sampled in October 2006

Statistical parameter	pH	OM %	Total N %	C:N	Mobile P mg/kg	Mobile K mg/kg
x_{min}	6.36	1.93	0.100	10.9	55	145
x_{max}	7.40	2.88	0.145	12.4	190	245
$\bar{x}$	6.76	2.39	0.120	11.5	116	184

The soil pH is slightly acid–slightly alkaline (RISSA, 1987), suitable for a large range of vegetables. Under a proper organic farming management, there are no signs that soil acidification may occur.

Going to the article subject to the soil acidification under organic farming, to ground its conclusions, the team led by Dr. TONCEA used a first reference an investigation carried in the Piedmont region of North Carolina (NEHER, 1999). To minimize the effects of differences in soil and climate, four fields (located in counties Franklin, Orange, Chatham and Alamance) with more than 8 years of organic management were paired with soils of similar soil map unit and geographic location that had been managed conventionally. It was not possible to identify a match for a fifth organically managed field (in Sampson). Out of four comparison pairs, three conventional and one organic farm had higher pH that the related pairs. The paper makes no discussion about the pH differences and focused on soil nematode communities.

The second reference cited a comparative study of organic and conventional arable farming systems conducted in The Netherlands to determine the effect of management practices on chemical and biological soil properties and soil health (DIEPENINGEN et al., 2006). Soils from thirteen accredited organic farms and conventionally managed neighboring farms were analyzed. Although a wide range of soil indicators were analyzed, the slight organic vs. conventional farms pH differences were not highlighted (as there was clearly no reason for). Soil type–clayey or sandy soil–in general had a much stronger effect on the soil characteristics than management type. The soil type was the one to influence soil pH.

With regard to the third important reference, we have failed to reach the full text availability of the cited article of DAVID BUCHAN, STEFAAN DE NEVE and NEELE AMELOT from Ghent University, Belgium (BUCHAN et al., 2009 cited by TONCEA et al., 2015), with its findings presented in the The 5th International Scientific Conference on Sustainable Farming Systems ECOMIT held in November 5-7, 2008 in Piešany, Slovakia.

However, it is no question that the first two references cannot back the conclusion that soil acidification is a common pattern in organic farming. Even the team of Dr. TONCEA has doubts (TONCEA et al., 2015): “The lower pH in organic fields comparative to conventional fields in Neher`s studies (1999) in North Caroline/USA and Diepeningen`s et al. (2006) studies in the Netherlands may have been due to chance…” (!).

Beyond the literature cited by Dr. TONCEA’s research, there are plenty of important papers (meta-analyses) that give a better insight of the effect that certified organic practices have on soils. The impact of organic farming on soil properties has been researched comprehensively (STOLZE et al, 2000), including an expert survey conducted in 18 European countries (by that time all EU-member states, plus Norway, Switzerland and the Czech Republic). Results show that organic farming tends to conserve soil fertility and system stability better than conventional farming systems. The environmental indicators for organic farming were based on the OECD list (1997) of environmental indicators for agriculture including soil organic matter, biological activity, structure and erosion. The issue of soil acidification was not a subject to notice differences between the two farming systems. Neither the chapter B. “Soil Chemical Properties”, of the most recent comprehensive study regarding the environmental impact of the conventional vs. organic farming practices underlines differences between the two systems with regard to soil acidification (GOMIERO et al., 2011). These very important baseline studies have not overlooked or neglected the issue of soil acidification but simply did not tackle it because soil pH alone cannot be a parameter to differentiate between organic and conventional agricultural systems under a meta-analyses holistic approach.

However, good quality research including pH measurements and discussing the effects of the certified organic practices on soil pH has been published since some time ago. A very much cited one reports the results from a 21-year study of agronomic and ecological performance of bio-dynamic, bio-organic, and conventional farming systems in Central Europe (MÄDER et al., 2002). Soil pH was slightly higher in the organic systems. The same superior soil pH levels under organic farming compared with conventional farming were recorded in a study carried by the University of Rostock (KAHLE PETRA et al., 2004). Also, soils from 10 farms in North Carolina (please, note the research done in the same US state by the first paper referenced by Dr. TONCEA), with a history of organic, sustainable, or conventional crop production were sampled in August 2001, May 2002 and May 2003 (LIU et al., 2007). Three of the farms were certified organic. They were located in Cedar Grove, Bear Creek and Ivanhoe. Among others, soil chemical properties (including soil pH), were assessed by the Soil Testing Laboratory of the North Carolina Department of Agriculture and Consumer Service (NCDA). The results show that soil pH levels, the cation exchange capacity and base saturation levels were significantly higher in soils from organic and sustainable than conventional farms.

Back to the research done by team of Dr. TONCEA, we cannot argue on the data measurements of the investigation performed on the soil pH evolution carried on both sites, in the Assistance Centre for Organic Agriculture, Fundulea, Călăraşi as well as the Research and Development Agriculture Station Piteşti, regardless that in the first location, the data on the chernozem soil pH evolution in the neighboring conventional plots are missing and the organic vs. conventional comparison seems fetched. More data on soil pH evolution on other conventionally managed fields belonging to the National Agriculture Research and Development Institute (NARDI) Fundulea-Călăraşi would have been more than welcome. There, there is available an impressive amount of results regarding the evolution of some soil agro-chemical indicators along more than 40 years of consistent investigations and plenty of relevant evidences for certain conventional management practices (synthetic fertilizers application), inducing the chernozem soil pH decrease (ŢINŢIŞAN, 2009). Moreover, two years only of soil pH measurements in the Research and Development Agriculture Station Piteşti seem not be sufficient to draw a clear conclusion.

Besides the listed local acidification possible causes (TONCEA et al., 2015), they may be some others like irrigation water quality or even deposition of acid rain caused by pollution.

But we totally disagree to use pH as an indicator of organic farming practices since our studies do not validate such proposal and beyond, there is another strong reason: soil performance is highly site specific (PHILLIPS, 2014). The soil pH depends much on the soil type, the buffering capacity and nevertheless, where is the case, slightly, on the type of organic fertilizer or soil amendment applied. Therefore, generalizing that organic farming leads to soil acidification does not make sense. Lowering of soil pH as a result of organic farming might be true in alkaline/saline soils (with high soil pH), while in case of (slightly and medium) acid soils is clearly site specific. An interesting comment received via "ResearchGate" (from Dr. ANOOP KUMAR SRIVASTAVA, principal soil scientist in the National Research Centre for Citrus, Nagpur, Maharashtra, India), states that reductions in soil pH in India are largely visible on alkaline soils/calcareous soils whether such effects are distinctively missing from acid soils. Moreover, soil acidification and soil pH decrease are not always entirely similar processes.

We are very sure that the team led by Dr. TONCEA is much aware of the abundant literature with regard to changes to soil pH in organic farming by applying soil amendments like dolomitic limestone or wood ashes (RODALE, 2011, STOIAN 2002). In fact, the soil pH periodically checking followed by a prompt intervention (whether is the case) is a matter of good local management, regardless the land is organically or conventionally farmed. As drastic changes of the soil pH cannot occur under (any kind) of a fair implemented management, neither the organic Romanian farmers, nor certification bodies and organic retailers should fear that organic farming carried on the long term would necessary lead in some decades (by using pH as an indicator of organic soil management) to hundred thousands hectares of Romanian arable land cultivated with only organic acid-loving bilberry (*Vaccinium myrtillus* L.).

CONCLUSIONS

The organic fertilization, with compost and/or green manure for over 15 years at the Research-Development Station for Vegetable Growing in Bacău, Romania, maintains a relatively stable level of soil fertility properties. The pH soil status check shows no significant changes over time.

The results oppose an investigation carried in Romania revealing that soil acidification is a common pattern of organic farming. The statement made that it makes scientific and practical sense to use the pH as indicator of organic management of the soils is based on local findings only and should not be considered as a reliable proposal. The statement is also grounded on the discriminately use of some measurements data recorded in the referenced papers. Generalizing that organic farming leads to soil acidification is inappropriate.

The organic farmers should entirely trust the already recognized environmental benefits of the organic farming carried under a proper management.

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