SHORT COMMUNICATION

THE INFLUENCE AND EXPLOITATION OF THE LIEBIG'S LAW OF MINIMUM IN THE PLANT NUTRITION AND SOIL FERTILITY IN THE CZECH TERRITORY

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The Liebig's mineral theory, and even the Law of Minimum resulting from it, met very soon response even in the Czech geographic region. Significant attention was paid to the relationships between nutrients and yield in the 2nd half of the 20th century in the field of plant nutrition and fertilization research. In ample scale, the plant analyses that enabled specification of these contexts, based on the Liebig's Law of Minimum, enabling determination of a causal relationship between yield formation and intake of nutrient in its minimum, were even exploited. The paper showed the geniality of the Liebig's idea on the dependence of the yield with nutrient in minimum. This also allowed exploiting this postulate in a wide scale of plant nutrition for optimisation of cultural fertilizer application during plant growth.

Justus Liebig; Law of Minimum

Introduction

Justus Liebig (1803–1873) was a great contributor to the European science of the 19th century. As an outstanding chemist, with his significant discoveries in the field of chemistry he contributed to the development of this scientific discipline. He determined circulation of matter in the living and non-living nature. In the world scale, he significantly developed rationalisation and progress in the agriculture activity not only in his country but also in other countries, particularly, the Czech Republic. He established himself within the agriculture science, particularly with the formulation of his theory of mineral nutrition that included not only the opinion concerning plant nutrition but also animal nutrition.

Justus Liebig (1803–1873)

The Liebig's Law of Minimum should be deserved with exceptional attention since it is a significant tool for the effective utilization of plant nutrients and for minimisation of plant nutrition adverse effect to environment. J. Liebig is a founder of agro-chemistry and its exploitation in agriculture. His work brought new impulses to science and positively acted through higher yields even on the performance of farm animals and subsequently, on the economy of agricultural units and agricultural industry.

Despite of the fact that the mineral theory was scientifically worked out and correctly explained the base of plant nutrition, the promotion of Liebig's work was not easy even in Bohemia.

The main argument against him was the fact that he underestimated the nitrogen recommendation to burn straw. He did not pay any great significance to humus and he underestimated a positive effect of farm manure on soil structure, water regime in soil, etc.

Even a recognised international Czech scientist – a biochemist, physiologist and agro-chemist, Julius Stoklasa (1857–1936) stressed the negatives, apart from high positive evaluation of the Liebig's work.

The Oekonomische Neuigkeiten und Verhandlungen, a weekly newspaper published in Prague (1826), referred to the Liebig's works yet at the beginning of his scientific carrier. The Justus Liebig's celebrity was in the memory of Czech farmers before 1840 and was even more famous after the year of publication of the basic work of Justus Liebig: "Organická chemie a její použití v zemědělství a fyziologii (Organic Chemistry and Its Exploitation in Agriculture and Physiology)". In this work, he simply and genially explained the circulation of matter and understandably showed the mutual relationships between the plant and animal kingdoms and also soil fertility as the country wealth.

The excellent and deep information on the Liebig's work was published by A. E. Komers in Czech in his publication "Důležitost nauky o výživě rostlin pro zajištění a zvýšení sklizní (The Importance of Plant Nutrition Theory for Ensuring and Increasing of Harvests)". Two extensive biographies on J. Liebig were published in Prague in 1943 and 1944 and the biography written by L. Skala (1996) were listed among the most important works.

This book presents J. Liebig to readers as being an outstanding reformer of agriculture, as a pioneer of agrochemistry and informs on published news and polemics on the Liebig's work in the Czech lands. In other chapter, it refers on retrospective view in application of the mineral theory into the agricultural activity, on the Komers's support and the possibilities of exploitation of the Liebig's theory and on the impulses resulting from this for the development of the agricultural experimentation and control activity. The influence on the development of the production of fertilizer on the economics of agricultural undertaking and the evaluation of the J. Liebig's work for the development of agriculture in Bohemia, Moravia and Silesia is further discussed in this book. In the end, the book informs a reader on the current status of exploitation of the Liebig's knowledge in Czech agriculture.

The evaluation of the Liebig's works in the Czech lands is confirmed by awarding him the Honorary Doctor of Philosophy Diploma and the Honorary Medicine Doctor Diploma from Charles University in Prague in 1848.

It is obvious from the works of the J. Liebig's Museum in Giessen, Germany, that J. Liebig kept his correspondence with many personalities in Bohemia and in Silesia. This is documented also by the "Zemědělské muzeum (Agricultural Museum)" library at Kačina near Kutná Hora in Bohemia (Czech Republic).

A group of Czech and Moravian scientists and teachers continued to develop his work and to spread it to schools and to agriculture practice at the end of the 19th and during the 20th century in the Liebig's work. Currently, the members of the "Česká společnost Justuse Liebiga (The Czech Society of Justus Liebig)", founded in Prague in 1994, work in this field.

Liebig's work reflection in the Czech territory

The Liebig's theory rapidly spread after its founding in the middle of the 19th century into the Czech geographic region. E. Komers, J. Horský, J. B. Lambl, F. Farský, J. Stoklasa and F. S. Kodym (he became the honorary Czech Liebig) were his most important propagandists. According to the Liebig's theory, F. S. Kodym showed to the Czech farmer what benefit could provide the applied agriculture chemistry. Skala (1996) referred in details (234 quotations) on a significant and wide public acceptance of the Liebig's work in the Czech region.

F. S. Kodym describes in Chapter XVII of his "Navedení k lučebnictví pro hospodáře (Introduction to the Applied Chemistry for Farmers)" (Prague 1853) the mineral theory as follows: "Carbon, oxygen, hydrogen, nitrogen these are four elements that were established by God as a basis of all living organisms from that, and from sulphur and other non animal substances innumerable numbers of the most diversified and even the most surprising animal and plant forms were formed... The Liebig's theory instructed us on the fact what substances are needed for living..."

The Liebig's mineral theory found a ready place in Bohemia and Moravia soon after his announcement and fertilization with bone meal, gypsum, lime and ash were routinely used on some local estates.

Prof. Dr. František Duchoň (1897–1975), a distinguished representative of plant nutrition in the Czech Republic, on the occasion of 100-year-anniversary of the Liebig's mineral theory evaluates the contribution of this well known and internationally recognised scientist for the Czech agriculture as follows: "If the Czech agriculture has advanced to the group of the most developed countries within the Continent, then, it was not due to a low credit of the mineral theory and of its author."

The Czech agriculture community has appreciated the Liebig's contribution to agricultural research permanently not only in spreading of his theory into the schools (Duchoň and the others) and in research (Kolářík and the others), but also by the fact that the community dedicated a monument of J. V. Liebig in his life size in front of the Agricultural School in Kadaň and by founding of the Czech Society of Justus Liebig in Prague in 1994.

The works of Duchoň and Kolářík, particularly in the field of the Law of Minimum, continued and were further developed by their follower Dr. J. Baier (1974) in his doctorate thesis: "Principy základních vztahů minerální výživy rostlin (The Principles of the Basic Relationships of Mineral Plant Nutrition)" that summarises knowledge of the Law of Minimum application in plant nutrition so that, as a logical consequence of empirical study of the nutrient influence on the creation of organic matter, to limit the parameters of this phenomenon with the aim to use them in practice in the cultivation of farm crops (Baier, 1974, 1979; Baier, Baierová, 1985).

Classical exploitation of the Liebig's Law of Minimum

The works of J. V. Liebig on the effect of mineral growth (vegetation) factors on the plant yield that are based on his "mineral theory" can be considered as the first among the most important knowledge in this field. As it is known, he formulated these discussed relationships in 1855 as follows: "The yield level of a plot (of the given character and composition) is in relation to that nutrient that is vital for a full development of plant and that is available in soil (in a suitable form and status) in the least amount (in minimo)."

As denominated by Liebig, this "Law of Minimum" (1862), quoted in his numerous tracts by their author, was gradually completed. Particularly, with the respect to the fact that the relationship of yield to the increasing fertilization by an adequate factor in minimum does exist only for a time when another factor is in minimum. In this relation, the author expressively states that the Law of Minimum is valid for all plant nutrients.

It is obvious from the quoted formulation that Liebig spoke only generally about "the relation" of yield to fertilization. However, there is a paragraph in the quoted work related to the soil nutrition strength and describing a "direct" relation.

This relation is expressed by the equation formulated later on:

$E = N - W$

(where E = yield, N = nutrition, W = resistance).

The explanation of this equation is as follows: The yield level corresponds or is in relation to nutrition (N) after subtracting of all causes and resistance (W) that block nutrition in the yield development.

The basic principle of the Liebig's Law of Minimum can be graphically symbolised as showed in Fig. 1 by Baule (1958).

The Liebig's theory in relation of yield to nutrients expressed in the "Law of Minimum" influenced for a long time the opinions of many scientists in the field of agro-chemistry that caused the following interpretations of the Law:

"The yield depends on a nutrient that is available in its minimum" (Scheffer, Welte, 1955), "Only such a factor is crucial for yield that is found just in its minimum" (Mengel, 1968), "Above all, yield is limited by a nutrient that is found in its minimum is soil" (Kundler et al. 1970), "Plant yield depends on a growth factor that is the most distant from the amount under which and under given amounts the highest yield would be achievable (construction)" (Duchoň, 1948), "Plant yield depends on a growth factor that is the most distant from the amount that would be needed for plant under given amount of other factors to produce the highest yield" (Kolářík, Prudík, 1952).

The Liebig's "Law of Minimum" was widely recognised among the society of scientists as a basic law on relation of the final production on the factors that influence it. By this scope, the Law exceeds the plant nutrition field. However, the discussed law was also criticised from the aspects having mainly theoretical and hypothetical character. The main reason was that experimental evidence on the linear dependency of yield on nutrients was missing.

It became gradually known in the field of the yield relationships that, in spite of many modifications and specification of the Liebig's theory, it is not possible to formulate this postulated relation between nutrients and yield that general validity could be confirmed experimentally in a wide scale.

Modern exploitation of Liebig's Law of Minimum within the soil plant relationship

Our work in the field of soil-plant relationship was founded by Dr. Ing. J. Kolářík in the Institute of Crop Production in Prague-Ruzyně, the Czech Republic, on the basis of the relationship among nutrients absorbed by plants and the yield. However, neither the way of looking for the so-called harmonic relation of nutrients – as an absolute criterion of high effectiveness of nutrients – proved its absolute validity.

Based on the fact that only a nutrient that is absorbed by plant can have a yield-creating function (Baier, 1974), we started to deal with the Liebig's Law of Mini-

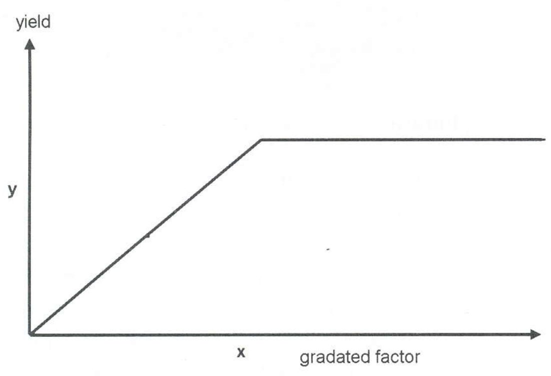

Fig. 1. Schema of the Liebig's Law of Minimum (according to Baule, 1956)

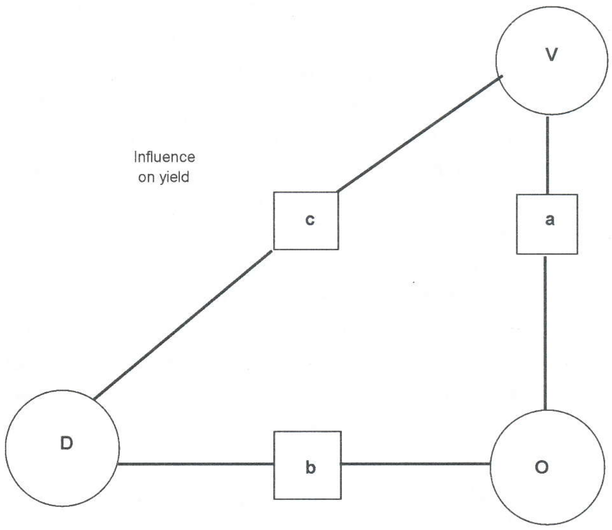

Fig. 2. Model of basic relationships between nutrients and yield (original Baier, 1972)

D – nutrient in nutritive environment (supplied in fertilizers and from soil supply), O – nutrients absorbed by plants, V – yield, a – exploitation of absorbed nutrients for yield formation, b – intake of supplied nutrients by plant, c – influence of supplied nutrients on yield mum validity in the field of nutrient intake and its exploitation for yield formation. Our assumptions were based on the knowledge summarised earlier in the paper "On the Utilisation of Nutrients for Photosynthetic Production" (1968).

A significant impulse was also the theory of Duchoň (1940), that... the most various combinations of different rates of fertilizers can achieve the same yields. The nutrients absorbed or, even better, the utilised nutrients are probably decisive in production than the added nutrients.

The formulated working model of the relationship between fertilization nutrient intake and yield (Fig. 2) showed a necessity to divide the study of the relationship between fertilization and the yield into two phases (nutrient intake and exploitation).

The following, generally valid relations (dependencies), can be derived from the below mentioned model:

1) Yield (*V*) is a relatively simple function (*a*) of nutrients absorbed by plant (*O*).
2) Absorbed nutrients (*O*) are very complicated function (*b*) into the environment of provided nutrients (*D*).
3) Yield (*V*), even resulting from a possibly variable nutrient intake, is a strong and very variable function (*b*) of supplied nutrients (*D*).

As related to the *b* phase of nutrient intake, it is dependent not only on the quantity and form of nutrients in soil (or in the atmosphere), but also on chemical, physical and biological properties of soil and also on the plant intake capacity. Therefore, it is difficult to look for a simple (rightful) expression of this relationship. Most often, the course of this relation is parabolic, however, there can be different shapes of this relationship (e.g. sigmoidal).

A similar situation was also found out concerning the relationships between the absorbed nutrients and yield, except for the fact that, compared to the *b* phase, we found a linear dependence of the yield on nutrient intake in phase *a*, supposing that it was in relation to the other nutrients in minimum.

The examples shown in Figs 3, 4 and 5 are evidence of this (Baier, 1974).

The fact that this linear relationship of the yield on nutrient intake (uptake) exists only for a nutrient absorbed in its minimum is documented in Fig. 6.

The listed dependencies demonstrated even by the results of other experiments (Baier, 1974, 1976, 1978) disclosed the existence of the Liebig's Law of Minimum and its general validity in the relationship between absorbed nutrients and the yield. In accordance with the Liebig's ideas, this relationship has two branches – an ascending linear dependence (in the interval when a monitored nutrient is in relative and absolute minimum related to other nutrients) and a horizontal (sustainable) yield value when a monitored nutrient does not influence the yield anymore (it has reached the area outside the minimum) and another nutrient overtook the function of minimum.

For easier expression of the listed relationships, we have created a working model where the dependence of created, the so-called, yield effect (a portion of yield on the unit of absorbed nutrient) is expressed as a relation of absorbed nutrients. This is based on the principle of the Liebig's Law of Minimum.

Due to this knowledge concerning the existence of the Liebig's Law of Minimum in the relationship of absorbed nutrients and formed yield, we were able to exploit it in our determination of the function of limiting nutrients.

The diagnostics of plant nutrition status conceived on the basis of this principle allow us to determine conditions of nutrient intake and their reflection in yield. We use this in practice for evaluating plot productivity and determining need for additional fertilizing based on plant inorganic analyses.

Thanks to the concept derived from the Liebig's Law of Minimum, our work resulted in formulation of the method, called VYNPOT.

Simply said, the VYNPOT principle is based on the fact that the sequence of limiting nutrients is determined

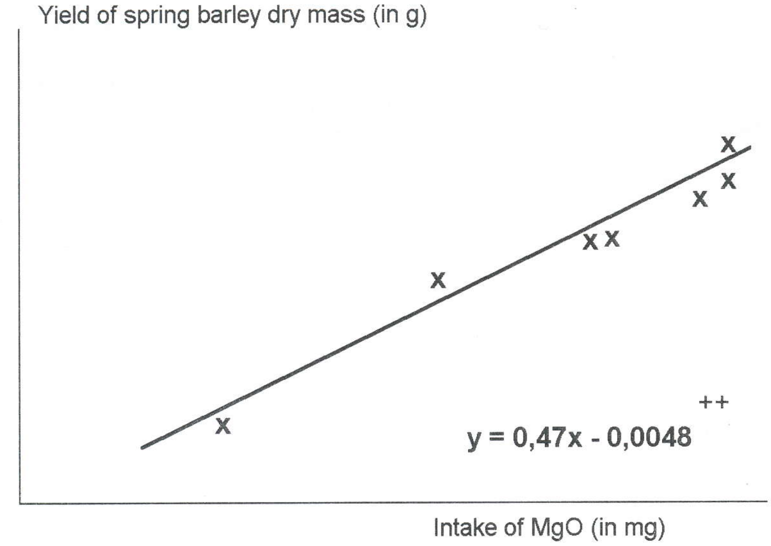

Fig. 3. Linear dependence of yield on nutrient in minimum (Mg–MgO) in spring barley

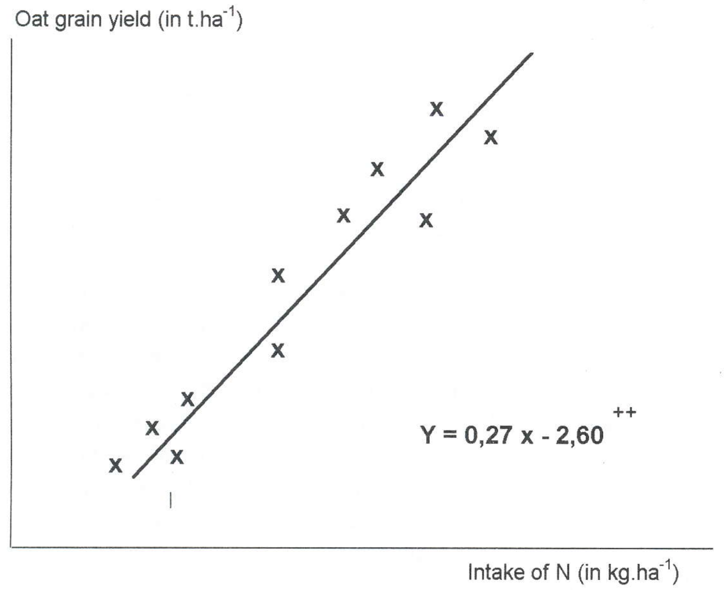

Fig. 4. Linear dependence of yield on nutrient in minimum (N) in oat

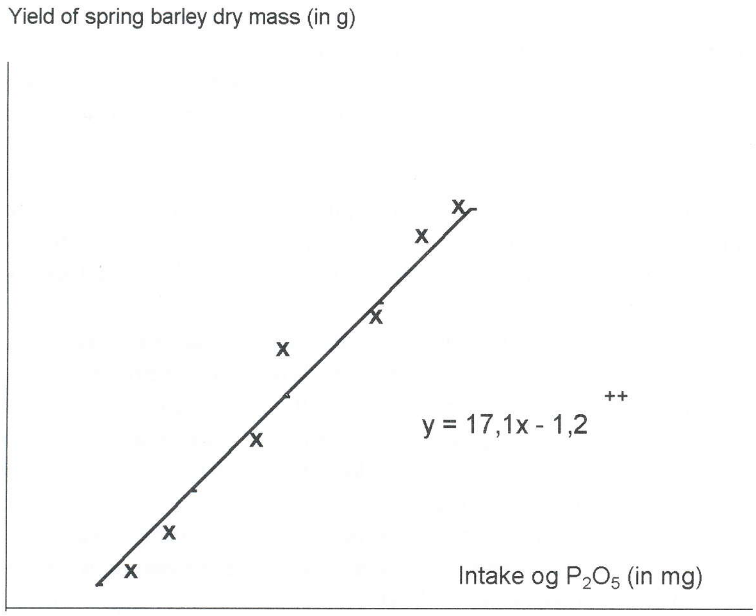

Fig. 5. Linear dependence of yield on nutrient in minimum ($P–P_2O_5$) in spring barley

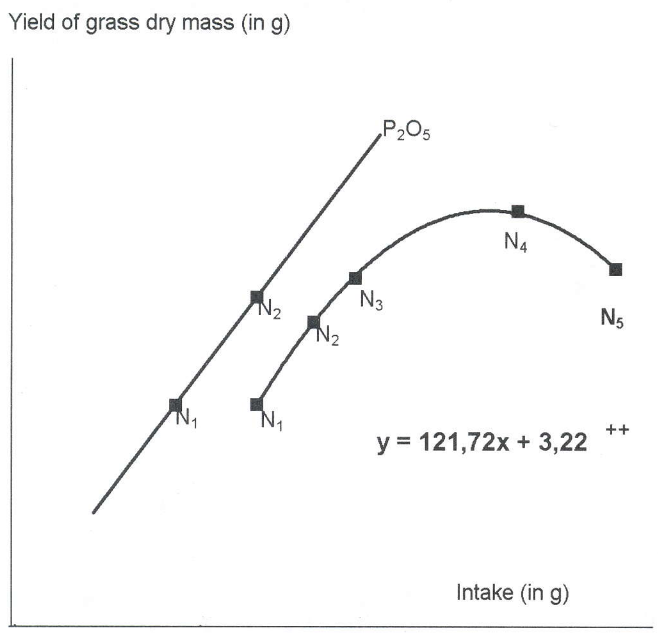

Fig. 6. Dependence of yield on phosphorus intake that is in its minimum (linear dependence) and on nitrogen intake that is not in minimum (non-linear dependence). Compiled by Baier (1974) according to the results of Knauer (1965) from experiment with orchard grass fertilized with elevated rates of nitrogen
Elevates rates N_1, N_2, N_3, N_4, N_5

Table 1. Overview of information gathered using principles of the VYNPOT method in the Czech Republic in 1998

Number of verified standpoint = 443		
1st limiting nutrient	Mg	in 52.4% of cases
2nd limiting nutrient	N	in 21.4% of cases
3rd limiting nutrient	K	in 17.6% of cases

according to dry matter weight of surface biomass and nutrient content in plants. Plant yield potential and a need, or a possibility of additional fertilization during vegetation, is derived from it.

The mentioned method of optimization of plant nutrition is based on the existence of the Liebig's Law of Minimum is used in the Czech Republic preferably for winter wheat in the form of point or running diagnostics. This method fully satisfies local agriculturists.

We were able to realise the VYNPOT method results from a randomly selected set of 4 growths of winter wheat in 1998 as follows (Table 1).

The basis for determination of limiting nutrient was a model created and based on the upper marginal concentration curves for young plants with dry matter weight within the interval from 0.2 to 3.0 g (Baier, Baierová, 1987) according to the idea of Møller-Nielsen (1973) for 3 to 9 tones of winter wheat grain yield. This model allows, under determination of plant mass (after calculation per plant) and nutrient content in the dry matter sample, to determine yield potential that could be achieved by plant. According to the Liebig's Law of Minimum, yield potential is determined by a nutrient that is in its minimum related to other nutrients. Therefore, this nutrient is called "a yield limiting nutrient" and its value is decisive for the determination of the plant yield potential and, simultaneously with it, even for the standpoint soil fertility and consequent measures for increasing of both parameters that are important for plant production.

This theory concerning the relationship of absorbed nutrient in its minimum to the yield (yield potential) makes possible a critical view on some traditionally considered relationships:

1) The causal relationship between nutrient content in plant dry matter expressed in per cent and created yield does exist only in the cases when plant dry matter weight is constant. We can encounter this situation, for example, in very young plants when the concentration of nutrients in dry matter expresses more or less the uptake value.

2) Therefore, the evaluation of nutrient intake according to nutrient concentration can be done only conditionally, otherwise, there could be distortion of the causality of searched relationship or contingency.

3) The classification of available nutrients in soil is not a unique and objective criterion of soil fertility, but it is only conditionally in its causal relationship to yield that is not determined by amount of nutrients in the soil environment, but nutrients absorbed by plants. Neither complex and demanding pot trials can identify a limiting nutrient only based on yield (even if there can be a certain relationship between the nutrient content in soil and its intake, as far as it is a nutrient in its minimum, and excluding all interfering influences).

In this case, the currently yet known fact considered in the evaluation of the soil analyses, e.g. antagonistic relation of potassium during magnesium intake, can be demonstrated. According to soil testing, there were only 21% of soils in the Czech Republic insufficiently supplied with magnesium, however, the monitoring of nutritional status of winter wheat in 1997 and 1998 showed, on the control standpoints of the Laboratory of Plant Nutrition Diagnostics, that there were 54.8% or 52.4% of growth, respectively, in which the yield was limited by magnesium deficiency.

It results from the above fact that knowledge on a nutrient in its minimum, i.e. the Liebig's Law of Minimum, can be fully exploited during the monitoring of plant nutrition status and not during the monitoring of nutrient supply in soil.

REFERENCES

BAIER, J.: Principy základních vztahů minerální výživy rostlin (The principles of fundamental relationships of mineral nutrition of plants) [Doctoral thesis.] VÚRV Praha-Ruzyně, 1974. 283 p.

BAIER, J.: Využití anorganických rozborů rostlin k dohnojování ozimých pšenic dusíkem (The utilisation of inorganic analyses of plants to additional fertilization of winter wheat varieties by nitrogen). Rostl. Výr., *22*, 1976: 1235–1243.

BAIER, J.: Soustava hnojení polních plodin (The system of fertilization of field crops). Praha, SZN 1979. 296 p.

BAIER, J.: J. Liebig – zakladatel racionální výživy rostlin (J. Liebig – the founder of rational nutrition of plants). Zemědělské noviny, Praha, 12. 9. 1990.

BAIER, J.: Justus Liebig – zakladatel agrochemie (Justus Liebig – the founder of agro-chemistry). Věstník ČSAZ, *XXXVIII*, 1991: 124–126.

BAIER, J.: Computer program for foliar fertilization. In: Proc. Symp. on Foliar Fertilization "A Technique to Improve Production and Decrease Pollution", Cairo, Egypt, 1995: 52.

BAIER, J.: Justus Liebig a ekologie (Justus Liebig and ecology). Zeměd. Aktuality, 1995 (8): 4–5.

BAIER, J.: Utilization of inorganic analyses of plants optimization of their nutritions state. In: Proc. 11th Int. Colloquium for the "Optimization of Plant Nutrition", Prague, 1996: 61–67.

BAIER, J. – BAIEROVÁ, V.: Abeceda výživy rostlin a hnojení (Alpha and omega of plant nutrition and fertilization). Praha, SZN 1985. 364 p.

BAIER, J., BAIEROVÁ, V.: Model vývoje výživného stavu ozimé pšenice pro různé výnosy (The model of development of nutritional habitus of winter wheat for different yields). Rostl. Výr., *33*, 1987: 367–372.

BAIER, J., BAIEROVÁ, V.: Využití dusíku a Liebigův zákon minima (The utilisation of nitrogen and Liebig's Law of Minimum). In: Proc. Sem. Funkce různých zdrojů dusíku v agrosystémech (Proc. Sem. on the Function of Different Sources of Nitrogen in Agrosystems), Praha, 1991: 97

BAIER, J. – BAIEROVÁ, V.: Listová hnojiva. Princip účinku mimokořenové výživy rostlin (Liebigův zákon minima) (Foliar fertilizers. The principle of the effect of out-root plant nutrition. /Liebig's Law of Minimum/). AGRA CZ a.s., Střelské Hoštice, 1997. 48 p.

BAIER, J. – SMETÁNKOVÁ, M. – BAIEROVÁ, V.: Diagnostika výživy rostlin (Diagnostics of plant nutrition). IVV MZVž ČR, 1988. 284 p.

BAULE, B.: Mitscherlichs Gesetz der physiologischen Beziehungen. In: Handbuch der Pflanzenphysiologie (IV.). Göttingen, Heidelberg, Berlin, Springer-Verlag 1958.

DUCHOŇ, F.: Biologické zákony o přibývajících a ubývajících výběžcích půdních a zákon hospodářské zastupitelnosti vegetačních faktorů (živin rostlinných) (The biological laws of increasing and decreasing soil projections and law of ecenomic representativeness of vegetation factors /plant nutritions/). Sbor. Čs. akademie zemědělské, *XV*, 1940 (3): 169.

DUCHOŇ, F.: Sto let minerální teorie (Hundred years of mineral theory). Věstník České akademie zemědělské, *XVI*, 1940: 409–419.

DUCHOŇ, F.: Výživa a hnojení kulturních rostlin zemědělských (The nutrition and fertilization of cultural farm crops). Praha, ČAZ 1948. 797 p.

KOLÁŘÍK, J. – PRUDÍK, J.: Všeobecné pěstování rostlin. Výživa rostlin. (General cultivation of plants. Plant nutrition). Praha, SPN 1952. 173 p.

KUNDLER, P. et al.: Mineraldüngung. Berlin, VEB Deutsch. Landwirtschaftsverlag 1970. 444 p.

MENGEL, K.: Ernährung und Stoffwechsel der Pflanze. Jena, VEB G. Fischer Verlag 1968. 436 p.

MØLLER-NIELSEN, J.: Kornplanters ernaeringstilstand vurderet og reguleret udfra, planternes kemiske sammensaetning. Kobenhavn, DSR Førlag 1973. 247 p.

SCHEFFER, F. – WELTE, E.: Lehrbuch der Agrikulturchemie und Bodenkunde. II. Pflanzenernährung. Stuttgart, Enke Verlag 1955.

SKALA, L. Významné osobnosti českého zemědělství (Outstanding personalities of Czech agriculture). Praha, Zemědělské nakladatelství BRÁZDA 1992. 109 p.

SKALA, L.: Ohlas díla Justuse Liebiga v Českých zemích (The response of the work of Justus Liebig in the Czech territory). Praha, Ministerstvo zemědělství ČR, 1996. 87 p.

Received for publication on September July 13, 2002
Accepted for publication on May 6, 2003

†BAIER, J. (Výzkumný ústav rostlinné výroby, Praha-Ruzyně, Česká republika):

Vliv a využívání Liebigova zákona minima ve výživě rostlin a půdní úrodnosti v českých zemích.

Scientia Agric. Bohem., *34*, 2003: 112–120.

Justus von Liebig (1803–1873) byl velkým přínosem pro evropskou vědu 19. století. Jako vynikající chemik přispěl významně svými objevy v oblasti chemie k rozvoji této vědní disciplíny. Stanovil koloběh hmoty v živé i neživé přírodě. Ve světovém měřítku se významně zasloužil o racionalizaci a pokrok v zemědělské činnosti nejen doma, ale i v dalších zemích, zejména českých. Do dějin zemědělské vědy se zapsal především formulací teorie minerální výživy, která zahrnuje názory nejen na výživu rostlin, ale i na výživu zvířat.

Liebigův zákon minima si zasluhuje mimořádnou pozornost, neboť je významným prostředkem k efektivnímu využívání rostlinných živin a k ekologizaci výživy rostlin. J. Liebig je zakladatelem agrochemie a propagátorem jejího využívání v zemědělství. Jeho dílo mělo také vliv na rozvoj pokusnictví, přineslo nové impulsy vědě, prospěšně působilo prostřednictvím vyšších sklizní i zlepšení užitkovosti hospodářských zvířat na ekonomiku zemědělských podniků a zemědělského průmyslu.

Přestože minerální teorie byla vědecky fundovaná a správně objasnila podstatu výživy rostlin, nebyla cesta Liebigova učení ani v Čechách lehká.

Bylo mu vytýkáno, že podcenil dusíkaté hnojení, doporučoval spalování slámy a humusu nepřikládal význam, neboť podcenil příznivý vliv hnoje na strukturu půdy, její vodní režim apod.

Také mezinárodně proslulý český zemědělský vědec – biochemik, fyziolog a agrochemik Julius Stoklasa (1857–1936) – vedle vysokého ocenění Liebigova díla poukazoval současně na jeho nedostatky.

O Liebigových pracích referoval již na počátku jeho vědecké kariéry v Čechách zemědělský týdeník Oekonomische Neuigkeiten und Verhandlungen, vydávaný v Praze (1826). Osobnost Justuse Liebiga, která byla v povědomí českého zemědělce již před rokem 1840, vynikla po tomto roce vydáním základního Liebigova díla „Organická chemie a její použití v zemědělství a fyziologii". V tomto svém díle jednoduše a geniálně vysvětlil koloběh hmoty a srozumitelně poukázal na vzájemnou souvislost rostlinné a živočišné říše a také úrodnosti půdy a bohatství země.

Fundovanou informaci o Liebigově díle vydal v českém jazyce v roce 1876 A. E. Komers v práci „Důležitost nauky o výživě rostlin pro zajištění a zvýšení sklizní". Dvě rozsáhlé životopisné práce o J. Liebigovi vyšly v Praze v roce 1943 a 1944. Mezi nejnovější práce je nutno zařadit bibliografii L. Skaly (1996).

Tato publikace představuje čtenářům J. Liebiga jako významného reformátora zemědělství a průkopníka agrochemie a seznamuje je s tištěnými zprávami a polemikami o Liebigově díle v českých zemích. V další kapitole uvádí retrospektivní pohled na pronikání minerální teorie do zemědělské činnosti, na Komersovu podporu a možnosti využívání Liebigova učení a na podněty, které z toho vzešly pro rozvoj zemědělského pokusnictví a kontrolní činnosti. Dále je uváděn vliv na rozvoj výroby průmyslových hnojiv, význam zákona minima pro ekonomiku zemědělského podnikání, ocenění práce J. Liebiga a její vliv na rozvoj zemědělství v Čechách, na Moravě a ve Slezsku. V závěru je čtenář seznámen se současným stavem využívání Liebigových poznatků v našem zemědělství.

Docenění Liebigových prací v českých zemích dokládá i udělení diplomu čestného doktora filozofie a diplom čestného doktora medicíny Univerzitou Karlovou v Praze v roce 1848.

Z prací Muzea J. Liebiga v Giessenu vyplývá, že Justus Liebig udržoval písemný styk s řadou osobností v Čechách, na Moravě a ve Slezsku, což dokládá také knihovna Zemědělského muzea na Kačině u Kutné Hory v Čechách.

Koncem 19. století a ve 20. století navázala na Liebigovo učení řada českých a moravských vědeckých a pedagogických pracovníků, aby jeho učení rozvíjela a šířila do škol a zemědělské praxe. K plnění tohoto úkolu přispívají v současné době i členové „České společnosti Justuse Liebiga", založené v Praze v roce 1994.

Justus Liebig; zákon minima

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Doc. Ing. Jan Baier, DrSc., 1926–1999

Dr. J. Baier was born on April 17, 1926 in Petrohrad, Bohemia in the family of chief-woodsman. After graduation from the secondary school in 1946, he started his study at the Czech University of Agricultural and Forestry Engineering in Prague. He graduated from this university in 1952. After his one-year practice in the agricultural company, he started his carrier at the Research Institute for Crop Production in Prague-Ruzyně. He worked there all his life, nearly 47 years, in the field of plant production and fertilizing. He was head of the Department of System of Fertilizing and, later on, head of the Department of Plant Nutrition Diagnostics and head of the Laboratory of Plant Nutrition Diagnostics.

In 1963, he achieved the scientific degree of Candidate of Agricultural Sciences (CSc., PhD). In 1981 he defended his doctorate theses on "Principles of Basic Relationships of Plant Mineral Nutrition" and he obtained his scientific degree of Doctor of Agricultural Sciences (DrSc.). On November 1, 1991, he was established Associate Professor for Agrochemistry.

Since 1974 he was the member of the Czechoslovak Academy of Agriculture (CSAZ). In September 1991, he was appointed as the Corresponding Member of the VDLUFA (Verband Deutscher Landwirtschaflicher Untersuchungs- und Forschungsanstalten). He was also the member of the following international organisations: The Union of German Agriculture Test and Research Institutes (VDLUFA), The European Society of Agronomy (ESA), The Association Justus-Liebig, Germany; The International Association for Optimisation of Plant Nutrition (IAOPN), The International Plant-Analytical Exchange (IPE), The International Soil-Analytical Exchange (ISE), The International Scientific Centre of Fertilizers (CIEC), The Society of Mg-Research, Germany.

He was the member of scientific boards, member of editorial boards and co-ordinator of many projects not only in the field of plant nutrition diagnostics but also in the field of fertilisation system. After 1989, he became a co-investigator of several international projects.

Dr. J. Baier was a significant Czech scientist and an excellent professional in the field of plant nutrition and fertilizing. His work is well known not only in the Czech Republic but also abroad.

He left to us his admirable work consisting of 52 books, nearly 150 original scientific publications, 89 research reports of research projects, more than 600 professional articles and publications, several patents and author's certifications.

Professional publics and practice from agronomy know Dr. Baier not only from his extensive publication activity but also from many seminars, conferences, congresses and colloquia where he actively participated and even organised some of them. He was the President of the IXth International Colloquium for the "Optimisation of Plant Nutrition", held in September 1996 in Prague.

During 10 past years, he was a participant of many congresses and conferences abroad where he delivered his lectures that were always prepared on high professional level. His lectures were highly evaluated by his foreign colleagues.

Dr. Baier succeeded in joining theoretic knowledge with the needs of practice that was permanently and tirelessly informed by him on novelties in the filed of plant nutrition and fertilizing. In this way, he significantly helped to increase the level of crop production in the whole former Czechoslovakia even in the Czech Republic alone. Based on inorganic plant analyses, he objectified decision-making process on crop fertilizing not only according to the supply of nutrients in soil but also according to the nutrient intake. This was a significant progress that got over the existing "system of recipes" in the past practice. As one of a few specialists, he was able to exploit the nutrition and fertilizing for the regulation of yield-creating process by the application of liquid and foliar fertilizers, particularly. He was responsible for their introduction and exploitation in broad practice.

He extremely appreciated the work of Justus von Liebig. He studied his works for all his life. After 150 years, Dr. Baier succeeded in the verification of the theory of Liebig's Law of Minimum that "functions" within the plants. It means that the nutrient that is contained in plant in its minimum amount limits the yield. Dr. Baier founded the Czech Society of Justus von Liebig in the Czech Republic and was its chairman.

Dr. Baier was good, sincere and diligent man that cordially loved his family and his work even all his friends that he had nearly all over the world. We bow to him with devotion and with gratitude for what he did for the development of science and agricultural practice and we admire his extensive lifetime work.

Editorial board