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SUMMARY

Sustainable agriculture is defined as the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources. A sustained increase of agricultural production becomes a great possibility for international community. In this process a green manure crops application for example crotalaria get a new chance for improvement process on soil fertility and soil conservation. Field experiment was carried out on a calcareous chernozem soil (Experiment station Nagyhörcsök of RISSAC-HAS) in partly of experiment series (3 years) at Hungary in 1998. The soil with about 20% clay, 3% humus, 5% $CaCO_3$ in its ploughed layer. To ensure a sufficient macro and micronutrient supply in the whole experiment, 100 kg N, 100 kg P_2O_5 and 100 kg K_2O were given hectare. The Crotalaria juncea L. and Crotalaria spectabilis ROTH were applied with 2 replications. Each plot has an area of 45 m^2 with 230-230 individual plants. In vegetation grown period were measured green and dry matter yield. The soil and plant samples were analysed for the macro and microelements contents. The main results achieved in 1998 are summarized as follows:

1. The green matter yield at before flowering reached 63.8 t ha^{-1} in case of Crotalaria juncea L.
2. Total dry matter yield at harvest (without roots) fluctuated between 9.6 and 17.0 t ha^{-1}, depending on the crotalaria species.
3. The average of element concentration (including stems, leaves of Crotalaria juncea L. and Crotalaria spectabilis ROTH) before flowering reached to 3.2 % N, 2.3 % Ca, 1.3 % K, 0.39 % Mg, 0.22 % P and 0.24 % S. The content of Al and Fe total 14 - 25, while that of Sr, Mn, Na, B and Ba 2 - 6 ppm in dry matter. The Zn, Cu, Mo, Cr, Se, Ni, As, Pb, Cd and Co concentration did not reach here the value of 1 ppm.
4. The average of biological activated element uptake (including stems, leaves of Crotalaria juncea L. and Crotalaria spectabilis ROTH) before flowering amounted to 368 kg N, 252 kg Ca, 96 kg K, 45 kg Mg, 30 kg P and 27 kg S ha^{-1}. The content of Al and Fe total 2 - 3, while that of Ba, Zn, B, Cu, Na, Mn and Sr 180 - 650 g ha^{-1}. The Co, Cd, As, Pb, Ni, Se, Cr and Mo concentration did not reach here the value of 10 g ha^{-1}.

By this means this green manures should have a vary important role in the design of rotations for sustainable agriculture. Not only do they help to retain and accumulate nitrogen and other nutrients, thus reducing leaching losses, they also maintain ground cover, protected the soil from erosion, and can make a contribution to pest and weed control.

Key words: Sustainable agriculture, soil fertility, soil conservation, green manure, Crotalaria juncea L., Crotalaria spectabilis ROTH.

INTRODUCTION

Sustainable agriculture is defined as the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources. A sustained agricultural production can be achieved by a proper use of soil resources, which includes the maintance or the enhancement of soil fertility (Christian and Kurt 1996). The term soil fertility is cast here to encompass not only essential plant nutrients but also aspects of soil structure, including water holding capacity, soil organic matter content and biological activity that influence both the efficiency of use and sustainability of the resources. All these attributes are interrelated and contribute together to the soil potential productivity or fertility (Kádár 1992, Németh 1996). From that perspective, soil fertility can be assessed as a capital stock, which will produce interests when properly used , and yet will be eroded by a consumptive use. It is necessary to make here a clear distinction between actions aiming at the regeneration of the soil capital, i.e., "recapitalization of soil fertility" and actions, such as maintance of enhanced soil fertility. The first set of actions, such as lime application, erosion control measures, and chiseling of sub-surfacehardpan, are "one time" investments which often benefit not only the farming communities but also society at large, improved water quality, food security, etc. Costsharing among all beneficiaries in society should be the carefully thought about. The second set of actions relates to the protection and or maintance of the enhanced soil capital, through balanced plant nutrition applications, appropriate crop rotations, etc., the cost of which have definitely to be fully supported by farmers. However, farmers will bear these costs only if the economic, institutional and legal frame conditions are favourable, i. e. when there are enough incentives to reinvest instead of consuming the capital stock. Possible interventions to enhance soil fertility management, therefore, range from policies affecting farm gate prices, security of land use, access to credit, access to markets, relations between input and output prices, fertilizer supply and distribution right through to access to information on improved soil fertility management (soil organic matter management, prevention of nutrient losses by run off - leaching, efficient use of fertilizers). This cannot be obtained with isolated measures and projects but requires a coherent strategy for soil fertility enhancement and sustainable soil management (Janssen 1993). The implementation of such a strategy, finally, requires a strong commitment of national governments which was often lacking in the past, as well as support from the international community. Neither human needs are satisfied, especially food demands, nor are the natural resources protected. Gross plant production was decreased with twenty percent in the last 10 years. Morever, this inadequate rate is obtained partly by degradation of the environment resulting from overexploiting of soil resources. The reversal of this trend and a sustained increase of agricultural production becomes a great possibility for Hungary and the international community. In this process a green manure crop application for example crotalaria get a great chance for improvement process on soil fertility and soil coservation (Lazányi 1998, Márton 1999). This paper briefly outlines the major effects of Crotalaria juncea L. and Crotalaria spectabilis ROTH on soil fertility and soil conservation.

MATERIAL AND METHOD

Field experiment were carried out on a calcareous chernozem soil at Hungary (Experiment station Nagy-hörcsök of Research Iinstitute for Soil Science and Agricultural Chemistry of the Hungarian Academy of Sciences) in partly of experiments series (3 years) in 1998. The soil with about 20% clay, 3% humus, 5 Ca CO3 in its ploughed layer. To ensure a sufficient macronutrient supply in the whole experiment, 100 kg N, 100 kg P2O5 and 100 kg K2O are given hectare in autumn of 1997. The Crotalaria juncea L. and Crotalaria spectabilis ROTH were applied with 2 replications. Each plot has an area of 45 m2 with 230-230 individual plants. Winter wheat was grown as a green crop (preceding the main product of a field) with commonly used agrotechnic. Soil samples are taken before the experiment set up on 27.04. 1998. Each composite sample consist of 20 subsamples drawn from the plow layer of each plot. Plant samples are taken during the vegetation period at least twice (20.07. 1998 and 02.11. 1998), using 5-5 plants per plot randomly. Plant material is dried, milled and digested in teflon bombs using cc.HNO3+cc.H2O2 and their total macro and microelement content with the exception of N was determined by ICP technics (JY 238 ULTRACE). N-content were determined by titration of hypobromit after the cc.H2SO4+cc.H2O2 digestion, N-NO3 content were determined by Griess-Ilosvai reaction after water extraction. Soil samples are extracted by ammonium-acetate+EDTA (Lakanen and Erviö 1971) and their available element content with the exception of N is mesaured using the ICP technics. N-contents (NO3+NH4) were determined by

Bremner-Keeney method (1966). Dates of experiment were estimated by MANOVA. The main goal of the whole researh program was described erlier (Márton 1999). Easily soluble nitrogen, phosphorus and potassium content of soil on ploughed soil layer are presented in Table 1.

RESULTS AND DISCUSSION

The green matter yield at before flowering reached 63.8 t ha-1 in case of Crotalaria juncea L. Total dry matter yield at harvest (without roots) fluctuated between 9.6 and 17.0 t ha-1, depending on the crotalaria treatment (Table 2). Chemical composition were different between crotalaria species before flowering. The average of element concentration (including stems, leaves of Crotalaria juncea L. and Crotalaria spectabilis ROTH) before flowering reached to 3.2 % N, 2.3 % Ca, 1.3 % K, 0.39 % Mg, 0.22 % P and 0.24 % S. The content of Al and Fe total 14 - 25, while that of Sr, Mn, Na, B and Ba 2 - 6 ppm in dry matter. The Zn, Cu, Mo, Cr, Se, Ni, As, Pb, Cd and Co concentration did not reach here the value of 1 ppm (Table 3). The average of biological activated element uptake (including stems, leaves of Crotalaria juncea L. and Crotalaria spectabilis ROTH) before flowering amounted to 368 kg N, 252 kg Ca, 96 kg K, 45 kg Mg, 30 kg P and 27 kg S ha-1. The content of Al and Fe total 2 - 3, while that of Ba, Zn, B, Cu, Na, Mn and Sr 180 - 650 g ha-1. The Co, Cd, As, Pb, Ni, Se, Cr and Mo concentration did not reach here the value of 10 g ha-1 (Table 4).

By this means this green manures should have been a very important role in the design of rotations for sustainable agriculture. Not only do they help to retain and accumulate nitrogen and other nutrients, thus reducing leaching losses, they also maintain ground cover, protected the soil from erosion, and can make a contribution to pest and weed control. For this reason based on earlier results crotalaria has the following charasteristics: nitrogen accumulation - maintenance-, reduction of nutrient leaching (N, Ca, K), reduction of soil erosion, improved utilisation of rainfall (water), shading of soil, aeration of soil, weed control and pest control. Crotalaria crops also provide cost reduction as a result of lower fertiliser use, improved nutrient utilisation, easier cultivation, reduced plant protection requirements. To a certain extent that this plant roots are involved in this process and green manure contribute to the biological stabilisation of soil structure following mechanical cultivation. Depending on soil type, the roots of crotalaria can extend down to 1.5-2 m according to earlier publications of autor. This result are presented that crotalaria has great advantagens in green manuring.

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Table 1. Easily soluble nitrogen, phosphorus and potassium content of calcareous chernozem soil in ploughed layer. Nagyhörcsök at spring of 1998.
Easily soluble N,P,K (ppm)
Ploghed layer N AL-P2O5 AL-K2O
(cm) NO3 NH4
0-20 15.7 21.0 108.9 180.5
20-40 8.7 17.5 59.8 111.5
Average 12.2 19.2 84.3 146

Table 2. Green and dry matter production of Crotalaria juncea L. and Crotalaria spectabilis ROTH on calcareous chernozem soil. Nagyhörcsök, 1998
Treatment Yield before flowering 20.07. 1998.
Green matter t ha-1 Dry matter t ha-1 Dry matter %
Crotalaria ju. L. 63.8 13.1 20.6
Crotalaria sp. ROTH 39.8 9.3 23.3
LSD5% 4.5 2.0 0.5
Average 51.8 11.2 21.9
Yield at harvest 02.11. 1998.
Crotalaria ju. L. 48.8 17.0 35.0
Crotalaria sp. ROTH 25.4 9.6 38.0
LSD5% 3.0 2.5 1.5
Average 37.1 13.3 36.5

Table 3. Chemical composition of Crotalaria juncea L. and Crotalaria spectabilis ROTH before flowering on calcareous chernozem soil. Nagyhörcsök, 1998
Element Concentr. Crotalaria Crotalaria Average LSD5%
junc. L. spect. ROTH
N % 3.70 2.70 3.20 0.60
Ca % 2.00 2.60 2.30 0.70
K % 1.70 0.90 1.30 0.30
Mg % 0.44 0.35 0.39 0.09
P % 0.27 0.18 0.22 0.01
S % 0.24 0.23 0.24 0.02
NO3 - N ppm 985.00 395.00 690.00 58.40
Fe ppm 317.50 210.50 264.00 25.10
Al ppm 249.00 152.50 200.70 14.00
Mn ppm 57.00 36.60 46.80 3.70
Sr ppm 53.60 72.90 63.20 2.30
Na ppm 49.50 24.90 37.20 4.70
B ppm 27.60 38.70 33.10 5.40
Zn ppm 16.10 17.30 16.70 0.40
Cu ppm 6.40 7.10 6.80 0.08
Ba ppm 4.80 38.50 21.70 6.40
Mo ppm 1.40 1.00 1.20 0.40
Cr ppm 0.60 0.50 0.50 0.50
Se ppm 0.60 0.30 0.50 0.10
Ni ppm 0.40 0.50 0.50 0.20
As ppm 0.27 0.07 0.17 0.08
Pb ppm 0.23 0.09 0.16 0.03

Cd	ppm	0.11	0.07	0.09	0.02
Co	ppm	0.06	0.01	0.07	0.04

Table 4. Element uptake of Crotalaria juncea L. and Crotalaria spectabilis ROTH before flowering on calcareous chernozem soil. Nagyhörcsök, 1998

Element	Amount	Cr. jun. L.	Cr. sp. ROTH	Average	LSD5 %
N	kg ha-1	484.70	251.10	367.90	68.90
Ca	kg ha-1	262.00	241.80	251.90	76.60
K	kg ha-1	107.60	83.70	95.60	22.00
Mg	kg ha-1	57.50	32.50	45.00	1.00
P	kg ha-1	35.40	23.90	29.60	0.10
S	kg ha-1	31.80	22.20	27.00	0.20
NO3 - N	kg ha-1	12.90	3.60	8.20	0.60
Fe	kg ha-1	4.10	1.90	3.00	0.280
Al	kg ha-1	3.20	1.40	2.30	0.16
Sr	g ha-1	700.00	600.00	650.00	20.00
Mn	g ha-1	700.00	300.00	500.00	30.00
Na	g ha-1	600.00	200.00	400.00	50.00
Cu	g ha-1	500.00	60.00	280.00	3.00
B	g ha-1	300.00	300.00	300.00	40.00
Zn	g ha-1	200.00	100.00	150.00	3.00
Ba	g ha-1	60.00	300.00	180.00	50.00
Mo	g ha-1	10.00	9.00	8.00	2.00
Cr	g ha-1	7.00	4.00	5.00	5.00
Se	g ha-1	7.00	2.00	4.00	0.80
Ni	g ha-1	5.00	4.00	4.00	1.00
Pb	g ha-1	3.00	0.80	1.00	0.10
As	g ha-1	3.00	0.60	1.00	0.40
Cd	g ha-1	1.00	0.60	0.80	0.03
Co	g ha-1	0.70	0.09	0.30	0.10

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