8th International Soil Science Congress on "Land Degradation and Challenges in Sustainable Soil Management"

May 15 - 17, 2012 Çeşme - İzmir / TURKEY

PROCEEDINGS

Volume-V

Nutrient Management for Soil Sustainability, Food Security and Human Health

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PROCEEDINGS BOOK

http://www.soilcongress.ege.edu.tr

This book of proocedings has been prepared from different articles sent to the congress secretary only by making some changes in the format. Scientific committee regret for any language and/or aim-scope

Takım Numarası: 978-975-96629-6-7

ISBN:978-605-63090-1-4 (5.c)

Printed by DEMFO Dijital Baskı ve Ofset +90 232 342 72 50
May 2012, İZMİR-TURKEY

PREFACE I

The 8th International Congress on Soil Science was held at the Altınyunus Hotel in Çeşme, Izmir, Turkey, from May 15th to 17th, 2012. The theme for this year was "Land Degradation and Challenges in Sustainable Soil Management". The congress was organized by Ege University's Department of Soil Science and Plant Nutrition, (Agricultural Faculty), and The Soil Science Society of Turkey (SSST). The congress also hosted the 6th International Conference on Land Degradation (ICLD).

The organization of International Soil Science Congresses is a long established custom for the SSST.
The 8 congresses held so far are listed below:

1998, Izmir:	1st International Congress on Soil Science
2000, Konya:	2nd International Congress on Soil Science
2002, Çanakkale:	3rd International Congress on Soil Science, organised by Onsekiz Mart University
2004, Erzurum:	4th International Congress on Soil Science, organised by Atatürk University
2006, Şanlıurfa:	5th International Congress on Soil Science, organised by Harran University
2008, Aydın:	6th International Congress on Soil Science, organised by Adnan Menderes University
2010, Samsun:	7th International Congress on Soil Science, organised by Ondokuz Mayis University
2012, Izmir:	8th International Congress on Soil Science, organised by Ege University

For this 8th International Congress we received more than one thousand abstracts from 54 countries worldwide. After a rigorous evaluation process, 655 of these were chosen for presentation either as seminars or posters during the congress.

There were two plenary lecturers: Prof. Richard Dick from Ohio State University, spoke on soil microbiology and Prof. Dr. Sergei Shoba from the Faculty of Soil Science, Lomonosov Moscow State University, talked about the challenges of soil degradation in arid areas.

The papers have been organized into five volumes according to topics for the Congress Proceedings Book The on-line version of these volumes is accessible at: http://www.soilcongress.ege.edu.tr.

We would like to take this opportunity to express our thanks to all the authors for their efforts in the preparation of these excellent contributions.

Yusuf KURUCU, Ph.D in Soil Science
Chair, The 8th ISSC 2012

PREFACE II

Today the world community has recognized the importance of sustainable use of soil, which is one of the key life-supporting components on the earth. As suggested in UN Conference on Environment and Development (UNCED) in 1992, soil degradation caused by over exploitation of fragile resources and misuse of marginal areas, degrease of potential agricultural areas by sealing, uneven distribution of potentially cultivable areas, declining trends in per capita food production, lack of adaptation of improved technologies by subsistence farmers, non-availability of essential off-farm input to resource poor farmers, and problems such as soil-mining should be considered in soil resources management plans.

Action programs are needed to protect and improve soil health by developing thematic strategies toward protecting soils from numerous of threads such as erosion, decline of organic matter content and biodiversity, sealing, soil salinizaiton, alkalinizitaion, flooding, and many others. Function of soils in environment in relation to human activates should be understood well to manage the soils without declining their quality. Unique role of a specific soil type for environment and human activities should be considered in managing soils to secure soil health, water quality, and food and fiber production for future generations. The evidence that we all depend on the thin layer of earth should be articulated to the people with no knowledge of soil and its importance. In addition, high quality technical information should be available and ready for growers, decision makers, government agencies, and so on for an effective use of science and technology in soil management.

This congress was organized to discuss issues in "land degradation and challenges in soil management". Interactions among soils, land degradation, and desertification were discussed and importance of soils for a better environmental quality and food security was stressed in the three-day congress. Poster and oral presentations covered a large spectrum of subject areas; including computer modeling, digital mapping, and new techniques and technologies used in data mining, decision making, and other related areas.

I trust that this proceeding will make a vigorous contribution to theoretical and practical soil science, and generate a prolific interest for appreciation of soil's importance to public well-being. I thank Organizing Committee and all worked and appreciate them for this high quality work.

Sabit ERŞAHIN, Ph.D in Soil Physics
President of Soil Sicence Society of Turkey
President of The Eurasian Federation of Soil Science Societies

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Mineral and Bacterial Fertilization Impact on Dehydrogenase Activity and Microbial Biomass in Acid *Eutric Cambisol* under Winter Wheat

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Abstract
An extensive application of the high rates of mineral fertilizers inhibit the growth and activity of soil microorganisms. Biodiversity can be maintained by application of nitrogen fixing microorganisms, which could present an alternative and/or supplement to mineral nutrition.
The aim of this study was to investigate the effect of non-symbiotic bacterial inoculants and different rates of mineral fertilizers on dehydrogenase activity and microbial biomass in acid eutric cambisol type of soil under winter wheat, based on the following variants: control (non-fertilized soil); 60 kg/ha N and P_2O_5, and 40 kg K_2O/ha ($N_1P_1K_1$); 120 kg/ha N, P_2O_5 and K_2O ($N_2P_2K_2$); *Enterobacter* sp. strains + $N_1P_1K_1$; *Enterobacter* sp. strains + $N_2P_2K_2$; *Klebsiella planticola* + $N_1P_1K_1$; *Klebsiella planticola* + $N_2P_2K_2$. The volume of soil microbial activity was estimated in the beginning and at the end of the plant growth. Dehydrogenase activity was estimated by spectrophotometer, while microbial biomass, in the form of CO_2-C, was determined by hloroform fumigation incubation method.
Studied parameters of microbial activity were significantly higher during the entire investigation period in the variant where combination of bacterial inoculants and lower rates of mineral fertilizers ($N_1P_1K_1$) was applied. The intensity of soil microbial activity was slightly higher in the full maturity phase of the wheat than in its phase of intensive growth.
It can be concluded that by applying bacterial inoculants we can effect on dynamics and direction of microbial processes that indirectly effect on increase and maintenance of the soil fertility and decrease the application of mineral fertilizers.
Keywords*:* Bacterial inoculants, mineral fertilizers, soil dehydrogenase activity, soil microbial biomass, wheat.

Introduction
The studies in the field of fertilization are mostly focused on the increase of the yield of crops whereas the traits of the cumulative effect of fertilizers (the change of biological and chemical soil properties, the content of biogenic elements and heavy metals etc.) have often been disregarded. Regardless of its major role in crop productivity and soil fertility, the application of mineral fertilizers (particularly nitrogen) may induce a series of negative consequences, from the microbiological, economic and ecological aspects (Acosta-Martinez and Tabatabai, 2000).
The coefficient of nitrogen utilization by crops is low (30-60%) and is being reduced even more with the increase of nitrogen fertilizers rates. The problems concerned can be overcome by partial replacement of these fertilizers by application of microbial inoculants, in order to inhibit or stimulate certain cellular processes, including mineralization ones, thus leading to the improvement of physico-chemical and biological soil properties (Milosevic et al., 2003).
Having in mind the above mentioned, the aim of this investigation was to examine the influence of different rates of mineral fertilizers [composite NPK (nitrogen:phosphorus:potassium = relation 15:15:15)] and their combination with selected soil bacterial inoculants, and sampling period on microbial biomass carbon and dehydrogenase activity in *Eutric Cambisol* and grain yield of wheat.

Material and Methods
The investigation was conducted on Mladenovac experimental station of Institute of Soil Science, located 55 km from Belgrade in Serbia, during 2007. Mean monthly temperature and precipitation summ for the investigated period are presented in Table 1.

Table 1. Mean monthly air temperature and precipitation summ for the study year.

Month	Year 2007		Mean 1990-2007	
	Temperature (°C)	Precipitation (mm)	Temperature (°C)	Precipitation (mm)
January	7.6	49.3	1.8	41.9
February	7.2	56.0	3.7	36.8
March	10.2	99.6	8.0	42.8
April	***14.9***	***3.8***	12.8	54.6
May	19.5	79.0	18.2	51.4
June	***23.8***	***107.6***	21.6	94.8
July	25.8	17.5	23.2	66.1
August	24.2	72.5	23.1	60.1
September	16.2	84.1	17.6	63.8
October	11.8	103.6	13.1	53.8
November	5.2	131.5	7.4	55.6
December	1.1	34.5	2.3	61.5
Mean	14.0	-	12.7	-
Total	-	839.0	-	683.2

The studied soil type was *Eutric Cambisol*. The experiment was set up in a randomized block design with three replicates, based on the following variants: control (Ø, non-fertilized soil); 60 $kg \cdot ha^{-1}$ N and P_2O_5, and 40 kg K_2O ha^{-1} (N1, low rates of mineral fertilizers); 120 $kg \cdot ha^{-1}$ N, P_2O_5 and K_2O (N2, high rates of mineral fertilizers); *Enterobacter* sp. strains + 60 $kg \cdot ha^{-1}$ N and P_2O_5, and 40 kg K_2O ha^{-1} (ES+N1); *Enterobacter* sp. strains + 120 $kg \cdot ha^{-1}$ N, P_2O_5 and K_2O (ES+N2); *Klebsiella planticola* + 60 $kg \cdot ha^{-1}$ N and P_2O_5, and 40 kg K_2O ha^{-1} (KP+N1); *Klebsiella planticola* + 120 $kg \cdot ha^{-1}$ N, P_2O_5 and K_2O (KP+N2). Winter wheat (cv. Evropa 90) was used as a test plant.
Nitrogen fertilizer was applied in the form of urea with 46% N, phosphorus – in the form of monoammonium phosphate with 52% P_2O_5 and 11% N, and potassium – as 40% potassium salt (KCl).
The pure culture of an associative N-fixing bacterium *K. planticola* was obtained from the stock culture of the Microbiology Laboratory of Faculty of Agronomy (Cacak, Serbia), while the *Enterobacter* strains (KG-75 and KG-76) were obtained from the stock culture of the Microbiology Laboratory in the Center for Small Grains (Kragujevac, Serbia), where they have been isolated from the rhizosphere of wheat.
Pure liquid inoculums of *K. planticola* and *Enterobacter* spp. were made using fermentors with suitable nutrient broth and incubated with aeration for 48 h at 28°C ± 1. The inoculation of the soil under young plants of wheat was carried out using plastic haversack sprinkler with 300.00 cm^3/m^2 of diluted liquid bacterial inoculum, previously made by adding the tap water in the pure bacterial liquid inoculum.
For the purpose of microbiological analyses the soil samples were taken in the beginning and at the end of the plant growth, from the plough soil layer (0-20 cm).
The following soil chemical parameters were analyzed: soil acidity - potentiometrically, using glass electrode pH meter; available phosphorus and potassium - spectrophotometrically and flame-photometrically, using Al-method by Egner-Riehm; humus content, using Tiurin's method, modified by Simakov; soil total N, using elemental CNS analyzer, Vario model EL III (Jakovljevic et al., 1985; Nelson and Sommers, 1996).
Microbial biomass carbon (MBC) was measured using the chloroform fumigation incubation method, based on CO evolution (Jenkinson and Powlson, 1976). Soil dehydrogenase activity (DHA) was assayed under standard conditions (24 hours of incubation at 30°C ± 1) by measuring the intensity of the red-coloured triphenyl formazan extinction, formed by reduction of 2, 3, 5 - triphenyltetrazolium chloride, spectrophotometrically (Thalmann, 1968).
The microbiological data obtained were analyzed by the method of the analysis of variance, using SPS Statistica 6.0 Software. The significance of the differences between the study factors was

compared by the LSD test at $P < 0.05$ and $P < 0.01$. The grain yield of wheat was calculated at 14% moisture.

Results and Discussion

The main chemical characteristics of the study soil sampled before the trial was set up are presented in Table 2. The soil is characterized by acid reaction, high available potassium and medium available phosphorus, humus and total nitrogen supply.

Table 2. Main chemical characteristics of the studied *Eutric Cambisol*.

Parameter		Mean	Standard deviation	Range
pH	nKCl	4.06	0.05	4.00-4.10
	H_2O	4.90	0.03	4.87-4.92
P_2O_5 (mg 100 g^{-1})		15.73	0.31	15.51-16.09
K_2O (mg 100 g^{-1})		25.30	0.30	25.08-25.65
Humus (%)		2.19	0.01	2.18-2.19
Total N (%)		0.136	0.005	0.132-0.141

The results of the microbiological study showed that the values of MBC and DHA in the soil depended on the fertilization variant used, as well as the sampling period studied (Tables 3 and 4). The analysis of the experimental data showed that the highest and statistically highly significant ($P < 0.01$) level of DHA and MBC inhibition in the soil was determined in the variant with high rates of NPK nutrients (N2) during both studied vegetation periods of wheat. Opposite to this, the highest and statistically highly significant ($P < 0.01$) stimulation of DHA and MBC in the soil was affected by applied combination of the microbial inoculants used and low rates of NPK fertilizers (variants ES+N1 and KP+N1).

Table 3. The effect of fertilization variant (A) and sampling period (B) on average dehydrogenase activity (µg TPF·10 g^{-1} of an air-dry soil) in *Eutric Cambisol* under winter wheat.

Variants (A)		Ø	N1	N2	KP+N1	KP+N2	ES+N1	ES+N2	$\bar{X}$B
Sampling period (B)	I	92.00	90.60	45.73	109.10	61.83	117.43	63.37	82.87
	II	96.30	92.93	36.83	123.17	69.83	132.17	64.17	87.91
$\bar{X}$A		94.15	91.77	41.28	116.14	65.83	124.80	63.77	85.39
LSD			*A*				*B*		
0.05			2.33				1.22		
0.01			3.09				1.62		

Table 4. The effect of fertilization variant (A) and sampling period (B) on average microbial biomass C (mg·kg^{-1} of an absolutely dry soil) in *Eutric Cambisol* under winter wheat.

Variants (A)		Ø	N1	N2	KP+N1	KP+N2	ES+N1	ES+N2	$\bar{X}$B
Sampling period (B)	I	46.54	37.53	19.33	72.96	26.42	90.51	28.67	45.99
	II	74.11	66.86	39.65	118.07	50.76	130.63	55.11	76.46
$\bar{X}$A		60.33	52.20	29.49	95.52	38.59	110.57	41.89	61.22
LSD			*A*				*B*		
0.05			12.24				5.22		
0.01			16.36				6.98		

Similar to our studies, results of the previous studies indicate that long-term application of high doses of mineral fertilizers significantly decrease microbiological activity in soil by decreasing soil pH and increasing N content in soil (Aciego Pietri and Brookes, 2008; Wang et al., 2009). Other findings (Csitari and Hoffmann, 2005) point out that different fertilizer treatments influence soil biological parameters significantly, but there is no linear correlation between them and the quantity of fertilizer active agents. Stimulative effects of the combine usage of the associative N-fixing

bacteria and low rates of NPK nutrients on soil MBC and DHA were also reported in previous studies (Raicevic et al., 2006).
According to our studies, the values of MBC and DHA also depended on sampling period studied. The highest values of MBC and DHA were determined in the second sampling period, which was, for MBC, statistically highly significantly more ($P < 0.01$), and for DHA statistically significantly more ($P < 0.05$) comparing to the first vegetation period of wheat.
The highest values of the studied parameters of soil fertility in the second sampling period is, probably, due to a better distribution of precipitation at the beginning of summer in the year studied. Similar to this, Nagaraja et al. (2002) reported that an increase in soil moisture status during the wet periods of the year resulted in higher biological activity.
The analysis of the yield of wheat grain showed the noticeable yield differences between the applied fertilization treatments (Fig. 1).

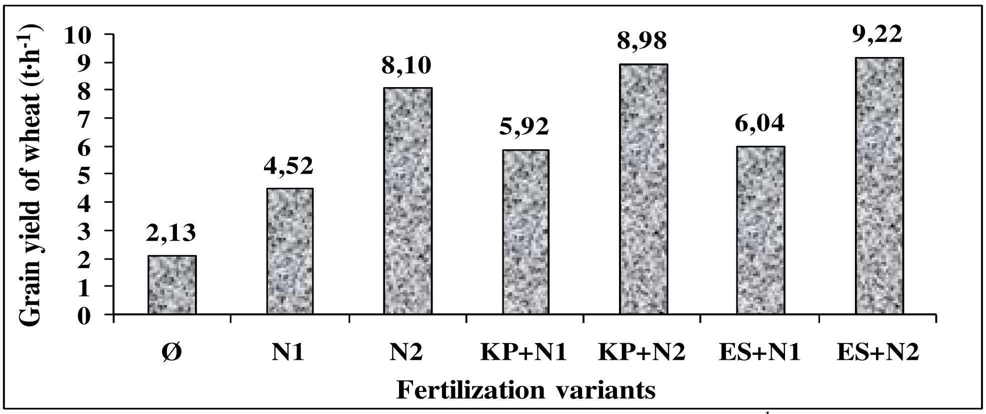

Figure 1. The effect of the fertilization variants on the grain yield of wheat (t·ha^{-1})

The highest increase in yield was obtained by combined application of bacterial inoculants used and high rates of mineral NPK fertilizers, although it should be noted that with combined usage of bacterial inoculants and low rates of mineral NPK fertilizers were obtained higher yields comparing to the application of low rates of the pure mineral nutrients (60 kg·ha^{-1} N and P_2O_5, and 40 kg K_2O ha^{-1}) in conditions of agricultural production typical for this study. Similar results were obtained in the study of El-Sirafy et al. (2006), in which a significant interaction effect of nitrogen fertilizers and microbial inoculation on wheat yield compared to the unfertilized variants was also found.
The character of the effects of the applied fertilizers on the yield of crop also depended on the weather conditions specific to each year of study. Specifically, good distribution of rainfall and temperature during 2006/2007 contributed largely to the achieved high yields of wheat in the investigated agro-ecological conditions, as indicated by other authors (Josipovic et al., 2005).

Acknowledgement
This study was supported by the Ministry of Education and Science of Republic of Serbia, Project No. TR-37006.

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