EFFECTS of LAUNDRY DETERGENT RESIDUES on SOME BBOCHEMICAL PROPERTIES of THE FARMING SOIL and SEEDS GERMINATION RATES

Serdar Bilen*, Kenan Barik

*University of Ataturk, Faculty of Agricultural, Department of Soil Science, Erzurum-Turkey, e-mail: sbilen@atauni.edu.tr

ABSTRACT

Laundry detergents play a very large role in daily life. Commercial laundry detergent, however, contains many irritating, and potentially toxic ingredients.

✓ **The objective of this study is to determine the effects of solution of different powdered laundry detergent (PLD), which is sold by the commercial market, on soil biochemical properties and seed germination rate under greenhouses conditions.**

Concentrated detergent solutions (Ccon) were prepared by taking into consideration the instructions indicated on the packaging of the medium soiled laundry (150 g PLD in 49 L water=3061 mg PLD L^{-1}) for each of six different PLD's (D_1, D_2, D_3, D_4, D_5 and D_6). Soils were taken from 0-30 cm depth from experiment sites. Polluted soils with six different concentrated detergent solutions were compared with non-polluted (control) soils about on soil biochemical properties (soil reaction, bacteria and fungi population and basal respiration (CO_2 respiration)) in two different textured (heavy texture and light texture) soils and four different time periods (0, 30, 60 and 90 days).

Ccon applications shown a significance ($p<0.01$) negative effect on bacteria and fungi populations in heavy and light texture soils at 0, 30, 60 and 90 days time periods. Ccon applications decreased soil bacteria and fungi populations and CO_2 respiration in light and heavy textured soils according to control soils. Significant differences were observed among different detergent solutions on seed germination rates. Ccon applications increased seed germination rates and shown a positive effect on corn and bean seeds germination rate.

Based on the results of this investigation, it was determined that commercial laundry detergent solutions or residues have a negative impact by depending on detergent type and ingredients of the detergent on soil reaction, microbial population, basal respiration and seed germination rates in polluted soils with detergent solutions.

Key words: Basal Respiration, Microbial Population, Powdered Laundry Detergent Residues, Seed Germination Rate

MATERIALS

Soil: Soils were collected from the research farm of Ataturk University, Erzurum, Turkey and the 0-20 cm depth.
Seeds : Bean (*Vicia faba*) as a cereal plant and corn (*Zea mays* L.) seeds as a industrial plants were used.
Powdered Laundry Detergents : Six Powdered Laundry Detergents (PLD) (D_1, D_2, D_3, D_4, D_5 and D_6) were used.

METODS

Soil Analysis : Initial soil samples analyses were shown in Table 1 and chemical analysis of the detergent solutions in Table 2.
Microbial Population Analysis : Viable bacteria (Ogram and Feng, 1997) and fungi populations (Alef, 1995) in 6 different detergent solutions were determinated at 4 different incubation periods (0, 30, 60, 90 days) and two different textured soil.
Basal Respiration : Basal respiration (BR), as a measure of soil biological activity, was determined by using *in vitro* static incubation of unamended field moist soil (Islam and Weil, 2000).
Seeds Germination Rate : Germination percentage of the corn and bean seeds calculated by USAID, 2015 .
Statistical Analysis : An analysis of variance (ANOVA) and Duncan's multiple range test ($p<0.05$) were performed to analyze statistical differences and to discriminate between means SPSS 17.

Soil properties	Ataturk University farmland	Daphan Plain farmland
pH (1:2.5)	7,19	7,47
Organic matter, g kg^{-1}	1,92	2,47
Lime ($CaCO_3$), g kg^{-1}	0,582	0,671
Total N, g kg^{-1}	0,19	0,12
Available P mg kg^{-1}	17,01	23,41
Salt, %	0,017	0,012
Electrical conductivity, mS m^{-1}	1.09	0.99
Cation exchange capacity, cmol kg^{-1}	38,63	46,71
Tarla Kapasitesi (%)	27,4	49,90
Solma Noktası (%)	13,8	28,16

Exchangeable cations, cmol kg^{-1} soil	Ca	Mg	K	Na	Ca	Mg	K	Na
	157,7	34,16	11,6	6,32	213,4	52,7	13,14	5,21
Microelements, mg kg^{-1}	Fe	Cu	Zn	Mn	B	Fe	Cu	Zn	Mn	B
	7,24	1,54	1,05	10,28	0,26	6,94	1,17	0,824	8,76	0,35
Particle size distribution, g kg^{-1}	Sand		Silt		Clay	Sand		Silt		Clay
	44,8		27,0		28,2	19,8		21,0		59,2
Texture Class	LOAM					CLAY				
Number of bacteria, CFU* g^{-1} soil	6.69 x 10^7					7.46 x 10^7				
Number of fungi, CFU g^{-1} soil	1.93 x 10^5					2.52 x 10^5				
Total C respired as CO_2, mg m^{-2} h^{-1}	3.2 (0.27 Mg C ha^{-1} y^{-1})					3.5 (0.29 Mg C ha^{-1} y^{-1})				

*CFU, Colony-forming units.

Table 1. Some initial chemical, physical and microbiological properties of the experimental soil.

Elements, ppm	Detergents Solutions					
	D_1	D_2	D_3	D_4	D_5	D_6
Na	1.058,831	1.222,313	936,063	969,994	1.104,208	510,471
K	82,582	35,084	65,918	31,311	191,151	12,428
Ca	21,104	19,580	52,648	45,108	84,263	16,048
Mg	5,746	22,302	13,701	1,755	3,081	11,435
P	6,198	8,517	39,632	17,331	23,723	4,738
S	1.078,770	2.192,227	396,617	1.278,216	2.179,422	1.040,610
Ba	0,021	0,086	0,268	0,270	0,587	0,015
Fe	1,619	1,823	1,288	0,879	0,778	0,849
Cu	0,322	3,209	9,846	17,936	14,973	2,636
Mn	0,302	0,117	0,450	0,260	1,911	0,439
Zn	1,808	2,482	13,317	16,043	22,387	0,171
B	8,392	12,645	6,578	6,961	14,060	253,031
Mo	0,057	0,189	0,918	0,345	0,497	0,436
Ni	0,196	0,155	0,874	3,642	0,509	0,168
Cd	0,024	0,050	0,004	1,194	0,373	0,009
Pb	0,976	0,571	1,317	1,597	1,273	0,793
Al	3,569	1,605	0,781	1,955	4,180	0,157
Cr	0,036	0,057	0,396	0,255	0,200	0,026
Se	1,117	0,387	3,233	0,851	7,530	0,810

Table 2. Chemical analysis of the detergent solutions.

RESULTS and DISCUSSION

Soil Reaction

- Soil pH value increased and changed soil pH class with increasing incubation days in different soil texture and Ccon applications.
- The highest soil pH values were observed at 90 days incubation period in D_2 detergent solution in light and heavy textured soils
- The lowest soil pH values were observed at 30 days incubation period in D_6 detergent solution (Figure 1).

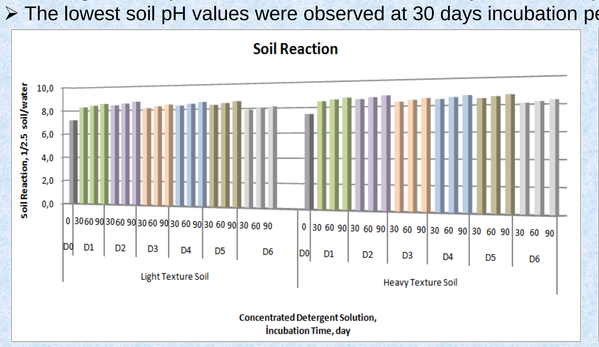

Figure 1. Effect of different detergent solutions, different incubation days in different textured soils on soil reactions.

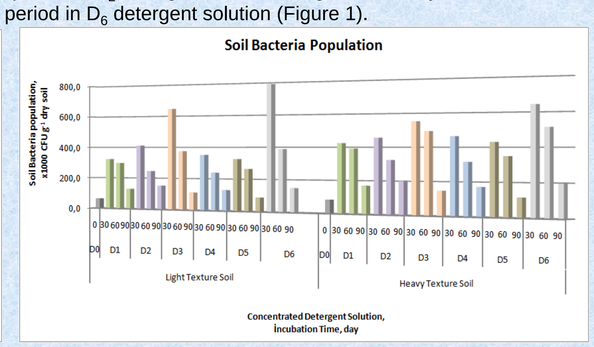

Figure 2. Effect of different detergent solutions, different incubation days in different textured soils on soil bacteria population.

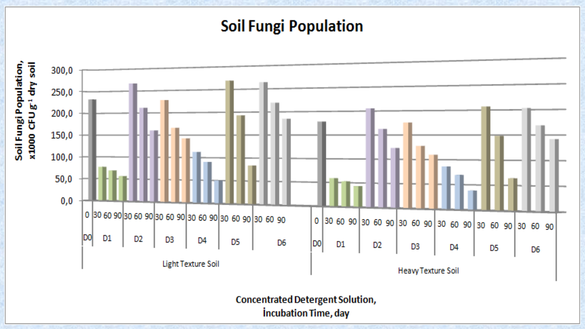

Figure 3. Effect of different detergent solutions, different incubation days in different textured soils on soil fungi population.

Bacterial and fungi population

- Ccon applications decreased soil bacteria and fungi populations in with increasing incubation days in different textured soils.
- The lowest soil bacteria populations were observed at 90 days incubation period in D_3 detergent solution in light textured soils.
- The lowest soil bacteria populations were observed at 90 days incubation period in D_5 detergent solution in heavy textured soils.
- The highest bacteria population value was observed at 30 days incubation period in D_6 detergent solution in light texture soil.
- The highest bacteria population value was observed at 30 days incubation period in D_5 detergent solution in heavy texture soil (Fig. 2).
- The lowest soil fungi populations were observed at 90 days incubation period in D_5 detergent solution in light and heavy textured soil.
- The highest fungi populations were observed at 30 days incubation period in D_5 detergent solution in light and heavy textured soil (Fig 3).
- Microbial populations in light texture soils showed high value than heavy texture soils in all incubation days and Ccon applications.

Soil Respiration

- Ccon applications increased soil CO_2 respirations with increasing incubation days in different textured soils.
- The lowest soil CO_2 respiration was observed at 90 days incubation period in D_1 detergent solution in light textured soils. The lowest soil CO_2 respiration was observed at 90 days incubation period in D_1 detergent solution in heavy textured soils.
- The highest soil CO_2 respiration was observed at 30 days incubation period in D_4 detergent solution in light textured soils. The highest soil CO_2 respiration was observed at 30 days incubation period in D_4 detergent solution in heavy textured soils (Figure 4).

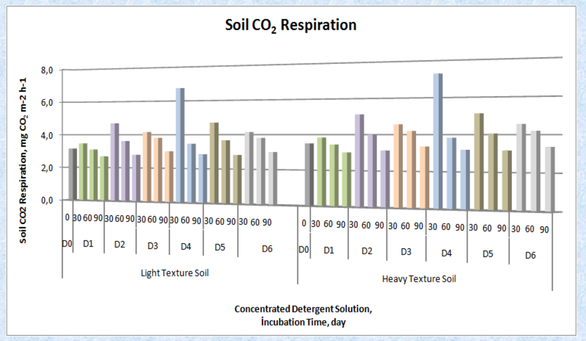

Figure 4. Effect of different detergent solutions, different incubation days in different textured soils on soil respiration.

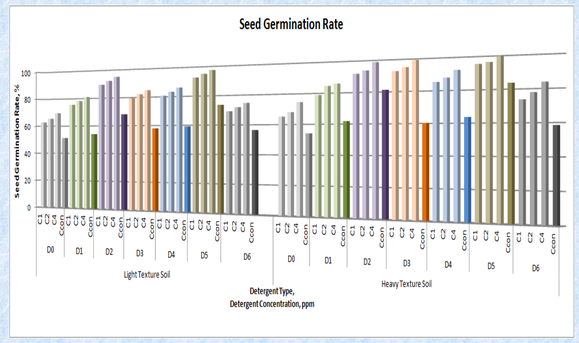

Figure 5. Effect of different detergent solutions, different incubation days in different textured soils on seed germination.

Germination Rate

- Seed germination percentages (SGP) generally increased with increasing incubation day periods and detergent concentrations (C_1, C_2 and C_4) in both light and heavy textured soils.
- The highest SGP was observed in C_4 concentration at D_5 detergent solution, light and in D_3 detergent solution in heavy textured soils.
- The lowest SGP was observed in Ccon concentration in D_6 detergent solution in light and in D_1 detergent in heavy textured soils.
- The highest SGP was observed in C_4 and the lowest observed in Ccon detergent concentrations in both light and heavy texture soils.
- SGP in heavy texture soils showed more high value than light texture soils in all incubation days and Ccon applications (Figure 5, 6).

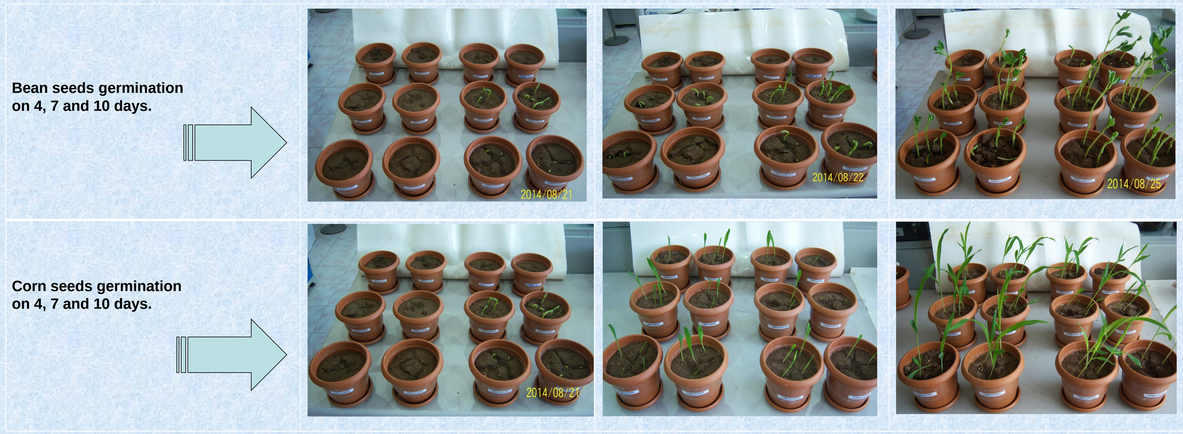

Figure 6. Effect of different detergent solutions in different textured soils on seed germination.

CONCLUSION

In this study, we examined the effects of different laundry detergent solutions on average soil pH, bacteria and fungi population, soil respirations and seed germination rate in soils.

√ Ccon detergent solutions have been contributed to increasing basic compounds in soil with increasing incubation days. The impact of laundry detergent ingredients on the environment depends largely on how wisely chosen and used detergent. Higher concentration of detergent led to higher pH of soils because of accumulation more salts in soils.

√ Detergent species could be regarded as pollution tolerant organisms and used as biological indicators for water pollution. Some of the detergents were highly toxic to living organisms also, the high doses of all detergents solutions were lethal to living organisms in soils. Especially, surface-active agents and phosphates, presented in detergent used during the current study, are the most toxic for on living organism population (numbers and composition).

√ Concentrated detergent solutions to soils induced a remarkable decrease in seed germination rates by depending on high doses of detergent concentration and inhibitory or toxic effects.

√ The negative effects of diluted detergent solutions have not been observe on seed germination. Diluted detergent wastes to be used in soil as irrigation water have been reduced the damages of agricultural land.

√ Diluted laundry greywater has good potential for irrigation in farmlands if the selected plant is able to remove pollutants (Na and metals) from greywater irrigated soils without adversely affected by surfactant residues and other pollutants.

√ However, further research is needed to determine if hyper accumulation of these nutrients in corn and bean plant has any adverse effect on human nutrition that may limit widespread use of laundry greywater in various soils and plants.

Acknowledgement
This research was supported by the Ataturk University Scientific Reasearh Project (BAP). Thank to the assistance of MSc Leyla Okyay in conducting this project.

REFERANCES

- Dökmeci, AH., 2009. Bazı Farmasötik İlaç Kalıntılarının Sulardaki Toksik Etkileri. T.C. Trakya Üniversitesi, Sağlık Bilimleri Enstitüsü, Toksikoloji Bilim Dalı, Doktora Tezi. Edirne.
- Lado, M., Ben-Hur, M., 2009. Treated domestic sewage irrigation effects on soil hydraulic properties in arid and semiarid zones: a review. Soil Tillage Res., 106:152-163.
- Maffei, M., 2014. Magnetic field effects on plant growth, development, and evolution, Frontiers in Plant Science, 5:445 DOI:10.3389/fpls.2014.00445.
- Misra, RK., Patel, JH., Baxi, VR., 2012. Reuse potential of laundry greywater for irrigation based on growth, water andnutrient use of tomato. Journal of Hydrology, 386(1-4):95-102.
- Pinto, U., Maheshwari, BL., Grewal, HS., 2010. Effects of greywater on plant growth, water use and soil properties. Resources, Conserv. and Recy., 54:429-435.
- Travis, MJ., Weisbrod, N., Gross, A., 2008. Accumulation of oil and grease in soils irrigated with greywater and their potential role in soil water repellency. Sci Total Enviro., 394:68-74.