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ARABIC SUMMARY

5- SUMMARY AND CONCLUSION

Two green house trials were undertaken conducted on El Gabal El Asfar soil treated with sewage untreated effluents for 0, 35 and 75 years.

The 1st experiment was designed to investigate the impacts of sewage effluents (SEF) pretreatment on soil and flax crop under fresh or sewage water irrigation and NPK or sewage sludge (SS) application.

The 2nd experiment was conducted on some pots of the virgin soil after harvesting flax plants, using soybean as a 2nd crop to investigate the residual effect of SS applied to the previous crop under the same of irrigation treatments.

The obtained results could be summarized as follows:

Experiment 1

1. All the growth and yield parameters except (the seed oil content) positively responded to the duration of soil pretreatment period, the dry matter yield, seed yield and oil yield were increased by about 81 & 91%, 70 & 89 % and 67 & 100% over the control due to the 35 and 75 years pretreatment, respectively. The seed oil content, however was reduced by about 4% and 7% under to the same periods of (SEF) pretreatment, respectively.

2. Both the dry matter and seed yield of flax were maximized under fresh water irrigation in combination with NPK application, and seed oil yield under sewage sludge application. However the oil content of flax seed was

maximized under the control treatment either upon irrigation with fresh or sewage water.

3. All the tested parameters except the dry matter yield of flax positively responded to fresh water irrigation, where the values of seed yield, oil yield, and oil content % amounted to about 1.78, 0.62 g pot^{-1} and 35.55% compared to 1.31, 0.48, 35.55% under sewage water irrigation.

4. Soil pretreatment of sewage effluents in general, adversely affected the oil seed quality of flax, while the untreated virgin soil showed the best quality of flax seed oil.

5. Sewage water irrigation adversely affected the oil seed quality of flax whereas the saturated fatty acids (SFA) values were increased from 5.63% to 6.76% while the unsaturated fatty acids (USFA) were reduced from 82.07% to 76.39% under fresh and sewage water irrigation, respectively.

6. Both the NPK and sewage sludge applications adversely affected the oil seed quality of flax, through inducing the undesirable parameter (SFA%) by 55% and 28% over the control treatment, respectively. On the other hand the desirable parameter (USFA%) was induced by 19 and 11% due to NPK and sewage sludge application over the control treatment, respectively.

7. Both content and total uptake values of K showed the greatest response to duration of sewage effluents pretreatment, while N was the least affected. The K content was increased by about 87% & 245% and K uptake by about 250 % and 582% , P content by about 58 an 91% and P uptake by about 178 and 262% with pretreatment periods of 35 and 75 years,

respectively, corresponding to (-25%) decrements in N content and 43& 53% increments in N uptake under the two pretreatment periods, respectively.

8. Sewage water irrigation tended to affect slightly K content in flax (9%) while N and P content were increased by about 36% over those of fresh water irrigation, respectively. As for nutrients uptake, the total uptake values of N, P, and K were increased by about 45%, 38% and 10%, respectively.

9. The sewage sludge and NPK application increased the values of the N content and uptake by about (29% & 82%) and (50% & 111%) over the control treatment, respectively, lower values were observed for P and least ones were observed with K.

10. The micronutrients and heavy metals content in flax plants responded differently to the applied treatments. However the total uptake average values of the tested elements were increased under sewage effluents application over the virgin soil in the order: Zn (300%), Pb (175%) Cr & Cu (150%), Ni (100%), Mn (43%), Fe (37%), Cd (5%), and Co (0.0%),.

11. All the tested elements in flax plants except Mn were increased and the total uptake values of these elements were also increased except to (Cd, Cr and Co), under sewage water irrigation as compared with fresh water irrigation.

12. As for the effect of the used treatments on soil properties, the followings are evident: (i) soil pH tended to be reduced under sewage effluents pretreatments, and NPK application as well as sewage sludge application. However the maximum

reduction in soil pH (2.23 unit) under sewage effluents pretreatment occurred under the 35 years treatment period .

(ii) Soil EC was materially reduced under fresh water irrigation (3.07 dSm^{-1}) as compared with sewage water irrigation (4.6 dSm^{-1} on average) and under sewage effluents pretreatments of 35 and 75 years (3.09 & 3.06 dSm^{-1}, respectively) as compared with the virgin soil (4.99 dSm^{-1}). On the other hand both NPK and sewage sludge fertilization increased soil EC from 3.35 in (the control) to 4.3 and 3.86 dSm^{-1} respectively.

(iii) Soil organic matter content tended to be constant under irrigation treatments but slightly increased (2.85% and 3.01%) under fertilization with NPK and sewage sludge, respectively. The dramatic increase from 0.14% in the virgin soil to 5.61% occurred under sewage effluents pretreatment for 75 years.

13. Soil available N, P, and K increased under sewage water irrigation as compared with the fresh water irrigation. Prolonging the (SEF) pretreatments up to 75 years gradually increased the soil content of available N, that N maximized, being increased by about (97%) under the 75 years period over that in case of virgin soil while the soil available content of K was dramatically increased under the 75 years period, but the soil available content of P was maximized under 35 years of SEF pretreatment. The fertilization treatments increased soil available N and P, on average, by about (37% & 16%) and (44% & 25%) due to NPK and sewage sludge

application, whereas the corresponding effect on soil available K was too slight (4% and 3%) respectively.

14. Soil available Mn, Ni, Co, and Pb, respectively showed the highest tendency to accumulate in soils through the sewage sludge applications while Cd was the least one and the other tested metals were in between the two extremes. While Cr accumulation in soils reached about 1133% over the virgin soil through the pretreatment period with effluents of 35 years, this increase was diminished to 867% only by the end of 75 years of effluents pretreatment.

15. The available fractions of the tested elements increased mostly under sewage water compared to the fresh water irrigation. Cd, Co, Cr, Ni, Mn, Cu, Fe, Pb and Zn being decreased in the order: 100, 18, 14, 13, 12, 5, 2, 1 and zero %, respectively. The NPK treatments induced the soil available elements after one growth season of flax by about 1, 6, 20, 9, 16 , 11, 7, 0.0 and 0.0 % for Fe, Zn, Mn, Cu, Cd, Ni, Pb, Cr and Co, respectively. Under sewage sludge application the corresponding (increments or decrements) of available elemental fractions amounted to about (+17%), (+18%), (-20%), (+17%), (+25%), (+12%), (+8%), (+9%) and (8%), respectively.

Experiment 2

1. The growth parameters of soybean i.e. dry matter yield, seed yield, and oil yield, responded positively to the previous application of sewage sludge to the previous crop (flax). In general the oil content, on contrary, was reduced with the

previous treatment of sewage water irrigation combined with sewage sludge application.

2- Both saturated and unsaturated fatty acids of soybean seed oil were induced under previous addition (flax treatment) of sewage sludge combined with sewage water irrigation. The unsaturated fatty acids % of soybean seed oil were increased while the saturated fatty acids were decreased under virgin soil and fresh water irrigation which led to best seed oil quality.

3- (i) The nutrients content of N, P, K, Cu, and Cd in soybean increased while the micronutrients; Fe, Zn, Mn, Ni, Pb and Cr content tended to be decreased under sewage water irrigation as compared with fresh water irrigation.

(ii) The total uptake of all the tested elements (except Co) were decreased under sewage water irrigation as compared with fresh water irrigation.

(iii) The previous application of sewage sludge to flax induced both content and total uptake of N, Zn, Cu, Ni and Cr, while both parameters (content and total uptake) were reduced for Fe and Mn. However, P, K, Cd and Pb content in soybean were reduced but their total uptake increased under the previous application of sewage sludge compared to the control treatment, except Co which was undetected.

4- (i) Soil pH was reduced with cropping under fresh water irrigation being decreased from 8.9 to 8.83 and from 8.8 to 8.56 after flax and soybean removal, respectively. Under sewage water irrigation, the soil pH was decreased after flax removal as result of sludge application, from 9.0 to 8.77

whereas after soybean removal no change in soil pH (9.0) could be detected.

(ii) Soil EC was increased after flax cropping under both irrigation water sources and fertilization treatments. Under fresh water irrigation and flax removal, the soil EC was increased from 3.6 to 4.73 dS m^{-1} but was reduced from 4.8 to 3.4 after soybean removal. Under sewage water irrigation and after flax removal the soil EC was increased from 4.94 to 5.44 whereas after soybean removal the soil EC was decreased from 6.28 to 4.74.

(iii) Under fresh water irrigation and flax removal, the soil organic matter content was decreased from 0.12 (imitially) to 0.11 % and from 0.12 (imitially) to 0.04 % after soybean removal. Under sewage water irrigation after flax removal the soil organic matter was 0.12 % and 0.13% after flax and soybean removal, respectively.

5. The available values of soil P, K, Fe, Zn, Mn, Cu and Pb increased under fresh water irrigation but N, Ni, Cr and Co decreased after removal of soybean as compared with their values before soybean planting whereas Cd value was almost constant. Under sewage water irrigation the available fractions of all the tested elements were increased except N, Cd & Ni which decreased after soybean removal as compared with their values before soybean planting.