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Nutrient and heavy metal content of rapeseed (B*rassica napus*) irrigated with treated wastewater

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Abstract. Field trials were conducted in winter season in two sites located about 20km north east of Cairo; Gabal Asfar farm (fertile soil) and Berka site (virgin soil).The trials aimed to evaluate the impact of rapeseed irrigation methods with secondary treated wastewater on yield ,quality trace elements and heavy metal content. The results clearly showed that rapeseed crop was not suited to the virgin soil as the crop produced 10% of the seed yield achieved at the fertile soil. There were significant increases in seed yield, straw and biological yields due to NPK application .Oil yields were 0.312 and 2.304 t ha^{-1} on virgin and fertile soils, respectively. Treated wastewater supplied rapeseed with 35,43and 156% of the recommended requirements of N, P and K, respectively in the virgin soil while the corresponding values in the fertile soil were 79,96 and191% for N,P and K, respectively. Trace elements and heavy metal additions from wastewater were very small Seed analysis indicated that the ranges of heavy metals were within the normal ranges expected and were far below levels that would be of concern due to the high pH of both sites.

Keywords: rapeseed, yield quality, wastewater ,heavy metals, trace elements

Introduction

The current water budget in Egypt show that the annual water demand exceeds the available fresh water by 6 billion m^3/year(Abou-Zeid,1992). Water uses are rising because of the ambitious land reclamation programme ,growing population ,steady rural development and urbanization plans and expanding the industrial sector. Therefore ,it is essential to develop water resources through untraditional ones.

Agriculture is one of the proposed outlets with an identified benefit from the recycling the nutrients in wastewater, WRc (2001) estimated that wastewater could offer about 30% of the crop requirements of N and 100% or more from crop requirements of K in sandy calcareous soil in Alexandria.

Therefore , the aim of this work is to evaluate the effect of treated wastewater on crop yield and quality under two types of Egyptian soils.

Materials and Methods

Two field trials were carried out in two sites located about 20 km north east of Cairo; Gabal Asfar farm (fertile soil) and Berka site (virgin soil). The trials aimed to evaluate the impact of rapeseed irrigation methods with secondary treated wastewater on yield, quality and heavy metal content. The area of each trial the was 10 feddans(4.2 hectars) close to the new Gabal El- Asfar wastewater treatment plant and the soil could be classified as loomy sand soil. The same area was chosen in the second site and located inside El- Berka wastewater treatment plant; the soil is gravelly sand and could be classified as virgin soil.

The experimental area was divided to large experimental unites according to the crop and the irrigation method . The design of each trial was based on 16 large plots ,eight of which receive wastewater only and the other eight receive wastewater plus supplementary fertilizer to be adjusted for each crop according to the normal recommended rates and for each site conditions. Rapeseed seeds(Pactol variety) were grown. In Gabal El Asfar site, surface irrigation was used; while in El Berka site sprinkler irrigation was used . The irrigation water was measured by water meter for each plot. Fertilizers were applied according to the normal recommended rates in Egypt. Nitrogen ,phosphorus and potassium were applied as ammonium nitrate(33.5% N),calcium super phosphate(15.5%P_2O_5) and potassium sulphate (48%K_2O) ,respectively. Samples of treated wastewater from Gabal El Asfar and El Berka

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were taken during crop cycle and analyzed for a range of agronomic parameters. Nutrient, trace elements and heavy metal loading rates to field trials were calculated according to the irrigation quantities applied to each crop (Table1).Rapeseed yields were determined ,seed oil ,nutrient and heavy metal content were determined. The obtained results were subjected to the proper statistical analysis using Cohort2 package, Costat programme.

Table 1. Mean Chemical Additions of Nutrients supplied by Gabal El Asfar and El Berka Wastewaters of Fertilizer for Canola in Fertile and Desert Soils to Canola at at Gabal El Asfar and Berka

Parameter	Gabal Asfar	Berka
Effluent (m^3/fd)	1640	2756
N (kg/fd)	15.9	35.4
P_2O_5 (kg/fd)	9.7	21.6
K_2O (kg/fd)	37.5	45.8
B (g/fd)	549	1006
Fe (g/fd)	594	1590
Mn (g/fd)	185	316
Cr (g/fd)	34	74
Ni (g/fd)	41	108
Zn (g/fd)	266	258
Cu (g/fd)	70	134
Cd (g/fd)	<8	<14
Pb (g/fd)	113	219
Mo (g/fd)	<16	<9
Co (g/fd)	16	9

Results & Discussion

Treated wastewater supplied rapeseed with 35,43 and 156% of the recommended requirements of N, P and K, respectively in the virgin soil while the corresponding values in the fertile soil were 79,96 and 191% for N, P and K, respectively (Table 2).

Data presented in Table 3 indicate that fertilizer increased rapeseed yields(seeds, straw and biological) significantly only at Gabal El Asfar. The data also show that rapeseed production under surface irrigation was greater than sprinkler irrigation. The oil content of rapeseed seed at El Berka was slightly larger (39.5%) than at Gabal El Asfar (38.2%), giving an oil production of 0.312 t/ha compared with 2.304 t/ha at each site, respectively.

Canola was not suited to the soil at El Berka, as this crop produced only 10% of the seed yield achieved at Gabal El Asfar. Canola is a relatively new crop in Egypt and so its yield characteristics are not yet fully evaluated under local conditions, but these results show clearly that canola is unsuited to infertile soil but can grow better in fertile soil

Table 3. Mean Yields of Canola at Gabal El Asfar and El Berka (t/ha).

Crop	Gabal El Asfar			
Yield component	Surface			
	No F		With F	
Seed	4.896b		5.76a	
Straw	19.056b		21.0a	
Biological	23.592b		26.76a	
Oil	1.870b		2.304a	
	El Berka			
Yield component	Surface		Sprinkler	
	No F	With F	No F	With F
Seed	0.57a	0.792a	0.432a	0.504a
Straw	6.504a	6.336a	3.600b	6.048a
Biological	7.080a	7.128a	4.032b	6.552a
Oil	0.228a	0.313a	0.171a	0.199a

Table 4. Nutrient Concentrations in Canola under Wastewater Irrigation, With and Without Added

Site	Fertilizer	N	P	K
Gabal El-Asfar	- F	4.31	0.53	0.94
	+ F	3.83	0.6	0.96
El Berka	- F	4.01	0.31	0.81
	+ F	4.22	0.47	0.82

Fertilizer, at Gabal El Asfar and El Berka (% DM).

All of the samples analysed had N, P and K concentrations within the normal ranges expected for canola (Table 4).

In addition to the major nutrients, wastewater also contains a wide range of contaminants reflecting the quality of the original sewage and the effectiveness of treatment. Secondary treatment will remove up to 90% of heavy metals into the sludge and so generally, wastewater contains small concentrations The ranges of concentrations of heavy metals are within the normal ranges expected for these crops, and are far below levels that would be of concern (Table5). Zinc and copper are essential trace elements, which are often deficient in Egyptian crops due to the generally high pH of soils. Some of these crop concentrations suggest marginally deficiency for zinc and likely copper deficiency for most crops, although this would have to be confirmed by foliar analysis. This poor trace element status would be anticipated at El Berka, having a high pH and small concentrations in the soil, and symptoms of deficiency were seen in a number of crops. At Gabal El Asfar, the larger crop yields would effectively dilute tissue concentrations, and the fact that tissue concentrations of these elements were similar between the sites, suggests

that the availability of these trace elements is limited, and deficiencies where noted in some crops.

This demonstrates, and confirms earlier findings (e.g. Cairo Sludge Disposal Study,1998), that the heavy metals in Gabal El Asfar soil are not readily bioavailable for crop uptake and do not represent a threat to the quality of the crops grown on this for human or animal consumption.Also, (WRc,2001) came to similar conclusion.

Table 5. Mean Concentrations of Heavy Metals in Summer and Winter Crops at Gabal El Asfar and El Berka.

Crop	Site	Zn	Cu	Cr	Cd	Pb	Ni
Canola	Gabal El Asfar	32.5	3.71	0.23	0.028	0.74	0.16
	El Berka	45.3	4.24	0.18	0.020	2.29	0.22

Note: Figures in bold for each element indicate the greater of pairs of mean concentrations for each crop

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