STUDIES ON THE EFFECT OF WASTEWATER IRRIGATION ON SOME ORNAMENTAL PLANTS

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دراسات عن تأثير الرى بمياه مخلوطة بمخلفات المصنع على بعض محاصيل الزينة

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ملخص البحث

أجريت هذه الدراسة على مرحلتين ، المرحلة الأولى أجريت فى مشتل تجارى يعتبر من أكبر مشاتل محافظة الاسكندرية وموجود فى منطقة الرأس السوداء ، مصدر مياه الرى لهذا المشتل يصب فيه مخلفات مصنع سيكلام لمنتجات الألبان كذلك تخلط معه مخلفات الماشية الموجودة فى عنابر تربية اسطبلات الواقعة على نفس مجرى المياه فى نفس المنطقة ٠

أجريت الدراسة بغرض بحث تأثير هذه المخلفات المخلوطة بمياه الرى على صلاحية التربة فى المشتل التجارى وبالتالى على بعض محاصيل الزينة التجارية والتى تروى من هذا المصدر خلال الثلاث سنوات الماضية ٠ وقد تم تحليل مياه الرى الملوثة ووجدت زيادة جوهرية فى BOD وأيونات الكالسيوم والصوديوم والبايكربونات والكلوراید و COD ٠ أخذت عينة من التربة والتى كانت تروى خلال ٣ سنوات الماضية بهذه المياه الملوثة وجدت أنها تحتوى على نسبة عالية من البوتاسيوم والحديد والنحاس ٠ درجة تركيز الأملاح (E.C) (التوصيل الكهربائى) زادت من ١,٧ الى ٢,٠ mmhos/cm. ٠ كانت محاصيل الورد والقرنفل وعصفور الجنة هى أكثر نباتات الزينة تأثرا من الرى بهذه المياه الملوثة ٠

فى المرحلة الثانية من الدراسة : أجريت فى مشتل الزهور والزينة بالكلية وتم استخدام نفس هذه المياه فى رى نبات الماريجولد (القطيفة) Tagetes

المزروع فى قصارى وكانت هناك تجربة مماثلة تماما ومقارنة فى المشتل التجارى ووجد أن خلط ٣٥٪ من المياه الملوثة بـ ٦٥٪ من مياه الشرب شجعت النمو الخضرى لنبات القطيفة • ولكن ثبط النمو جوهريا عندما تم خلط ٧٠٪ من المياه الملوثة بمياه نقية واحترقت النباتات تماما عند استخدام مياه الرى بدون أى تخفيف • محتوى الأوراق من العناصر الثقيلة لم يتغير فى حالة الرى بالمياه الملوثة كذلك التربة النامية فيها لم تتأثر نظرا لقصر مدة الرى التى لم تتعدى ٤ شهور فيما عدا زيادة جوهرية فى تركيز الملوحة (E.C) والتى ارتفعت نتيجة للرى بالمياه الملوثة •

ABSTRACT

Field and experimental studies were conducted to determine the effect of some contaminatants which reached the water stream from a variety of sources near Ras El-Soda area (Alexandria) on some ornamental crops in a commercial nursery and on marigold plants plants in two separate studies. In the first one the combined (industrial and animal wastes) lead to large increase in microelement level in nursery surface soils. Roses, carnations and bird of paradise plants suffered much. Water samples indicated significant increases in bod, calcium, sodium, bicarbonate, chloride and cod. Soil samples taken from area irrigated for 3 years with wastewater contained a higher concentration in K, Fe and Cu. E.C. was increased from 1.7 to 7.0 mmhos/cm. Growth of marigold plants was stimulated by 35% wastewater (+65% tap-water) irrigation but did not tolerate 100% wastewater treatment and with 100% mortality. Leaves of tagetes plants irrigated with wastewater accumulated similar concentrations in heavy metals uptake. Heavy metal content of the potted soil irrigated with wastewater was generally close to the control (tap water). E.C. was markedly increased when the potted soil was irrigated with 100% waste water.

INTRODUCTION

Pollutants discharged from chemical industries are considered an important menace to human life. Their drastic damage to agriculture is poorly understood, especially under the Egyptian environment. Each pollutant has a primary effect on various crops either

by killing directly or by changing their physiology that the composition and growth of the crops are drastically changed (Kirkham, 1986).

Million gallons of wastewater were discharged daily in Alexandria city. This effluent is usually highly enriched with plant nutrients. These nutrients which may cause adverse effects in lakes and streams, may be utilized in irrigation and cause a harmful effect on vegetation. The phytotoxicity of these industrial effluents has to be determined.

The aim of this work was to study the number of contaminants which reached the water stream from a variety of sources near Ras El-Soda area on some ornamental crops in a commercial nursery. The effect of irrigation with this polluted water on marigold plants was also investigated in two different locations. Many disputes have been raised between farmers and factories for this reason.

MATERIAL AND METHODS

* First experiment:

This experimental work was carried during March 1985-Oct. 1986.

Study area:

The location of the commercial nursery was 200 meters south of Siklam Dairy Proccessing Factory in Ras-El-Soda area-Alexandria. This Nursery is the largest commercial nursery in Alexandria with 10 feddan production area and producing cut flowers, pot and container plants as well as greenhouse and foliage crops. For the last 5 years, nearly half of this production area irrigated by water taken from stream canal where Siklam Dairy Proccessing Factory and an animal production station that operated by the army; discharge

their effluents in this stream. There were estimated to be a minimum of 50 head of cattle feedlot on this station. This station use dry manure handling methods. The second half of the production designed to produce container plants and irrigated by tap water.

Dairy plant (Siklam Dairy Factory) discharges the following quantities in the drainage system (Hamza and Gallup, 1982).

Volatile material = 6.0 ton/day
Oil and lipid = 1.0 ton/day
Bod = 1.2 ton/day
Cod = 3.7 ton/day
Rate of liquid waste drainage = 0.8 m^3/day
Suspended matter = 3.0 ton/day

During and after the experiment, samples of plant tissues and soils (from depth of 20, and 50 cm) and irrigation water were collected and analysed for metal and a lot of other chemical and physical properties (Tables 1,2,3 and 4). Chemical analysis of the tested effluents were carried on the same tested wastes according to the standard methods for water and wastewater analysis (1975). Trace metal analysis were conducted using acid digested wastes aspirated in jarrel ash 750 atomic absorption spectrophotometer.

* Second experiment:

A pot experiment was run to study the effect of the wastewater effluents on single ornamental crop. This experiment was conducted during January-October-1985. Weekly samples were obtained upstream and downstream of the same wastewater stream. This wastewater was mixed with tap water at the following dilutions (by volume):

TABLE (1) : CHEMICAL ANALYSIS OF SOIL TAKEN FROM THE NURSERY AND IRRIGATED BY WASTEWATER OR TAP WATER.

CONSTITUENTS		SOIL IRRIGATED WITH TAP WATER	SOIL IRRIGATED WITH WASTWATER	
PH		7.60	7.30	
E.C MMHOS/CM^{-1}		1.7	7.0	**
POTASSIUM	:	29.2	136.0	**
	:MG/100 GM	----		
PHOSPHORUS	:	20.8	20.8	
FE	:	14.3	33.0	**
CU	:	16.7	69.0	**
	:PPM			
MG	:	200.4	216.1	
ZN	:	19.9	26.8	
CALCIUM CARBONATE		19.8	27.0	**
SILT (%)		28.0	29.0	
SAND (%)		62.0	64.0	
CLAY (%)		8.0	7.0	

1- E.C = ELECTRICAL CONDUCTIVITY.

TABLE (2): ANALYSIS OF WASTEWATER EFFLUENT PRODUCED BY DAIRY PROCESSING FACTORY AND ANIMAL PRODUCTION STATION.

CONSTITUENT		TAP WATER	WASTEWATER
E.C.[1]	MMHOS/CM	0.11	6.25 *
PH		7.1	7.6
CALCIUM	MEG/L	0.50	5.0 *
SODIUM	MEG/L	0.26	4.74 *
POTASSIUM	MEG/L	0.04	0.66 *
BICARBONATE	MEG/L	0.69	3.87 *
NITARTE + AMMONIA -N	MEG/L	61.0	140.0 *
TOTAL DISSOLVED SOLID	MEG/L	0.43	1.4
B.O.D[2]	MEG/L	32.2	356.0 **
C.O.D[3]	MEG/L	872.0	1567.0 **

1- E.C = ELECTRICAL CONDUCTIVITY
2- BOD = BIOLOGICAL OXYGEN DEMAND
3- COD = CHEMICAL OXYGEN DEMAND

TABLE (3) INFLUENCE OF WASTEWATER IRRIGATION AT DIFFERENT CONCENTRATIONS ON GROWTH PARAMETERS OF TAGETES PLANTS.

WASTEWATER MIXIURE	HEIGHT (CM)	FRESH WEIGHT (GMS)	DAYS TO FLOWERING
(TAP WATER) ZERO %	35.6 a	46.8 b	66 a
35 %	44.7 a	58.7 a	71 a
70 %	20.4 b	25.4 c	63 a
100 %	died	died	died

TABLE (4):CONCENTRATION OF HEAVY METALS IN TAGETES LEAVES

% WASTEWATER	ZN MG/GM	FE MG/GM	CU MG/GM
(TAP WATER) ZERO %	0.038	0.037	0.002
35 %	0.036	0.028	0.001
70 %	0.051	0.033	N.D.-1
100 %	0.078	0.026	N.D.

1- N.D. = NON DETECTABLE

TABLE (5): CHEMICAL ANALYSIS OF POTTING SOIL OF TAGETES PLANTS IRRIGATED WITH WASTEWATER AFTER 90 DAYS OF IRRIGATION

POTTING SOIL IRRIGATED WITH	PH	E.C MMOHS/CM	ZN MG/G	FE MG/G	CU MG/G	P MG/G	NO3 MG/G
TAP WATER	7.2	1.7	0.087	0.48	0.06	1.4	0.17
100% WASTEWATER	7.4	7.0	0.108	0.53	0.06	1.1	0.77

1- 100% wastewater
2- 70% wastewater + 30% tap water
3- 35% wastewater + 65% tap water
4- 100% tap water (control).

Plant selected for this experiment was Tagetes erecta L. seedling with 10-15 cm height were transplanted in 25 cm diameter pots in/ loam/sand media. The seedling were irrigated every 3 days with the different wastewater treatments.

Two set of experiments were carried out, first set was located at the commercial nursery. Similar and second set was conducted at Ornamental Research Station; Faculty of Agriculture-Abis-Alexandria.

Soil samples for potting were analyzed at the end of the experiment at the International Center of Rural Development (Amerya-Alexandria).

At the end of the experiment, leaf samples were dried and then grounded. The ground materials were analyzed for heavy metals using the atomic absorption spectronetry. Both leaf samples and chemical analysis of the tested effluents were analyzed at the high institute of Public Health-Alexandria University.

Tagetes plants were hand watered and no fertilizer was added. Both two set of the experiments were designed as randomized blocks with 4 replications each.

The replicate unit consisted of 4 plants (sub-samples). Flowering dates were determined and was considered to be the number of days from seeding to the opening of the first flower. Plant height and fresh weight were recorded at the end of the experiment.

RESULTS

Field study (nursery observations):

Heavy application of wastewater and animal wastes enriched in metals lead to large increase in micro-element levels in nursery surface soils (Table 1). Their accumulation represents a long range potential for phytotoxicity.

Apparently some physical, chemical, and biological problems were associated with irrigation by wastewater to ornamental crops in the nursery. Our observations indicated that, roses, carnations and bird of paradise (sterlitzia) plants suffered much. These crop cultivated cut flowers and grown on polluted water showed chlorotic leaf tips, necrosis and leaf abscession especially in the lower parts. Dieback symptoms on some of these plants especially roses were common. Instance of salt injury to roses and dahlia plants grown in soil irrigated by wastewater have been reported. On the other hand, plants irrigated with tap water did not produce any symptoms related to polluted water. A permeability problem occured in the surface layer of the soil and may be related to the relatively high salinity concentration.

The nutrients which were in excess of plant needs reduced crop quality.

Analysis of irrigation water: Water samples obtained upstream and downstream indicated significant increases in bod, calcium, sodium, bicarbonate chloride, cod and total suspended solid. This large increase of nutrients formed when excessive amounts of animal waste and milk processing wastes are disposed with watering on the nursery soil (Table 2).

Soil analysis: Soil samples were taken at random from different area irrigated with wastewater contained a higher concentrations in potassium, Fe and Cu. E.C. was increased from 1.7 to 7.0 mmhos/cm.

Concentrations of phosphors, Mg, Zn, calcium carbonate, showed little or no increase in polluted soil compared with soil irrigated with tap water (Table 1).

Second experiment: This experiment was carried out as a pot experiment. Tagetes plants (marigold) were selected for this trial.

A- Morphological symptoms: Plants grown on 70% wastewater showed, chlorotic, leaf tips, necrosis and leaf abscission in the lower parts. Concentration of 35% of tap water irrigation showed no signs of abnormality.

B- Plant growth and flowering: The heighest growth was obtained from zero and 35% concentration while height of plants irrigated with 70% concentration was significantly decreased compared with the control (Table 3). Marigold plants did not tolerate 100% wastewater treatment. Those plants had 100% mortality.

On the other hand, mixing tap water with 35% wastewater stimulated fresh weight which was nevertheless, significantly reduced when irrigated with 70% wastewater. Flowering date was not affected significantly by any treatment in this experiment (Table 3).

C- Leave content of heavy metals: The analysis of marigold leaves which has received wastewater treatment show little but nonsignificant increase in heavy metals uptake (Table 4).

D- Potted soil content of heavy metals: The soil used for potting the seedlings was analyzed at the end of the experiment (Table 5).

Heavy metal content of the soil irrigated with wastewater was generally close to the control (tap water). Concentration of No.3 was slightly increased compared with tap water treatment. However, E.C. was also markedly increased when the soil irrigated with 100% wastewater.

DISCUSSION

The nutrients in wastewater (e.g. nitrogen, phosphorus ...) provide fertilizer value to crops but in certain instances are in exces of plant and soil needs and cause delayed growth, maturity and may impire yield and water quality. For example, heavy applications of farm manures to land may, in addition to elevating the nitrate contents of soil and water, produce ammonium toxicity of plants (Hinesly, 1971). The hieght and fresh weight of plants irrigated with 25% wastewater was stimulated. There were many reports of stimulatory effects upon enzymes caused by low concentration of heavy metals in irrigation water (Stenlid, 1975; Rock and Blood-Good, 1959).

In these experiments, instances of salt injury to tagetes plants following irrigation by wastewater have been reported. Leaves of tagetes plants showed leaf burn and chlorosis. This may be due to excessive EC. Sodium in wastewater which can substitute for other cations in the soil (Kirkham, 1986). This substitution tends to disperse clay particles in the soil, leading to decreased permeability. Marigold plants under 100% wastewater irrigations regime had 100% mortality. Salinity might be the single most important factor in killing plants when exceeded the normal rate (above 7 mmhos/cm) (Kirkham, 1986).

This study indicates that irrigation by wastewater did not produce difference in leaves content of heavy metals. Because the

analysis was carried out in the leave, heavy metals taken up by plants tend to remain in the roots (Kirkham, 1986).

The bod and cod were high in the wastewater. Manning (1973) demonstrated that, sewage and paper industries add considerable wastes to waters. Rapid decomposition of the materials by aerobic bacteria greatly depletes the water's oxygen content which increase bod and cod.

Recycling wastewater might be avialable option for increasing horticultural crop yield and production as well as future water supply. Some additional treatments can be made before such water can be used for agricultural and landscape irrigation.

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