Growth And Metals Accumulation In Guar (Cyamopsis Tetragonoloba) Irrigated With Treated Wastewater

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Abstract: The effect of different concentrations of treated wastewater (0, 25, 50, 75 and 100%) on growth performance and metals accumulation of two lines of Guar (Cyamopsis tetragonoloba) seedling (L18 and L53), under nursery conditions were investigated. The experiment was conducted using a completely randomized design with three replicates.. Plant height, leaves number, fresh weight and dry weight were measured after 60 days. Besides, the concentration of copper, manganese, zinc, chromium and nickel were determined for both stem and leaves of the tested lines. The results indicated that the development of both lines was significantly affected by the application of wastewater. However the concentration of metals was of no consistent pattern in leaves and stem of both lines. The results demonstrate that the ability of plant lines to accumulate metals as observed depends on wastewater concentration and the type of metal. These results suggest that using treated wastewater at different concentration will benefit and not harm Guar plant; however, the greater growth will be achieved with 100% concentration of the treated wastewater.

Keys word: wastewater, guar, metals accumulation, growth

1. Introduction:

As a result of urban and rural expansion, in the last decades, large quantities of wastewater are available in many developed and developing countries. Different treatment techniques have been proposed and applied in order to address this worldwide problem, taking into account the source of the pollution (Pescod, 1992). In Khartoum there are many plants for wastewater treatment, one for industrial and other for domestic wastewater. For example about nine millions gallon of domestic sewage water is pumped daily to soba plant treatment, which was used for the irrigation of green belt, south Khartoum. (Taha, 2002) It is generally accepted that, the disposal of treated wastewater, whether it is generated from domestic or industrial plants, is a topic of concern due to its potential effect on environment (Bhati and Singh, 2003). Among various disposal methods of wastewater, agriculture is typically considered as one of the fields where application of treated wastewater shows its beneficial effects (Feigin et al., 1991) In addition, wastewater, depending on its origin may be considered as a valuable source of plant nutrients and organic matter needed for maintaining fertility and productivity levels of the soil (Moore, 1988). However, it may contain undesirable toxic materials and pathogens that pose negative environmental and health impacts (Lubello et al.,2004).Guar (Cyamopsis tetragonoloba) is an annual legume crop, grown as vegetable for human consumption and forage for animal, the endosperm of guar seeds contain gum ,which is gaining importance as food and non- food item (Ashraf et al., 2002). Agricultural use of wastewater may improve growth, biomass and plant quality, however, it can lead to accumulation of toxic level of heavy metals in both soil and plant tissues (Day et al., 1979). Therefore, it is important that, the consequence of application of these materials should be well investigated.. The objective of this work was to study the short-term effect of using treated sewage water, on growth performance, biomass and accumulation of nutrients and heavy metals in guar seedling, grown under nursery conditions.

2. Materials and methods:

The experiment was carried out at the nursery of Environment and Natural Resources Research Institute, Khartoum. Guar (Cyamopsis tetragonoloba) seeds (L18 and L53) were sown in pots containing 5 kg of soil The wastewater used for the irrigation of the experiment was obtained from Soba Treatment plant. This plant, receives mixture of domestic and industrial wastes. Plastic pots were used for raising guar seedlings, irrigated daily with 200 ml of five different concentrations of treated wastewater, 0, 25, 50, 75 and 100% (v/v). The treatments were assigned in a completely randomized design with 3 replicates of each treatment. For the study of growth performance, biomass, and minerals concentrations in guar tissues, seedlings were harvested from the nursery after 60 days of growth. Ten seedlings of guar were harvested randomly from each replicate to study the impact of sewage water treatment on the shoot length, leaves number, fresh weight, dry weight and minerals accumulation in stem and leaves of the tested lines. The shoot length of ten seedlings was measured with meter scale. At the same time, fresh weight and dry weight of each seedling were estimated independently. Dry biomass was determined after oven drying for 48 h at 80°C. The concentration of copper, manganese, zinc, chromium and nickel were determined by dry ashing and extraction of the samples according to the method described by (Pearson, 1981) and analyzed by using , atomic absorption spectrometer. Perkin Elmer model 3110. Results were statistically analyzed using the analysis of variance procedure. Duncan's multiple comparison tests (DMRT) was used for means separation (Gomez and Gomez, 1984).

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3. Results and discussions:

3.1. Physicochemical properties of Treated wastewater:

Table1 shows the general properties of treated wastewater and well water used for the irrigation of the experiment. The data indicated that treated wastewater near neutral (pH = 6.33) while well ware was neutral (pH = 7.0). The treated wastewater contained high levels of nutrients. In terms of heavy metals concentration lead, chromium and nickel were lower than the recommended limits for constituents of reclaimed water for short term irrigation; therefore it can be accepted as water for short term irrigation (WHO, 2002)

3.2. Growth performance:

The effect of treated wastewater irrigation on growth performance of guar lines, leaves numbers, plant height, fresh weight, dry weight, are shown in table 2, 3, 4, and 5 respectively. It was observed that application of wastewater affected plant height in significantly for both lines. The highest plant height and leaves number (59.67cm and 12.11) were obtained at the 100% wastewater treatment for L18 and L53 respectively. Moreover, the highest fresh and dry weight (19.68 g and 3.34) were also obtained at the 100% wastewater treatment for L18 and L53 respectively .differences in growth and biomass production under different concentration s may be due to metals concentration, and my partly due to total solids which might have affected the osmotic relation of the seedling (Swaminathan and Vaidheeswaran, 1991). Greater growth and biomass of the 100 % treatment is obviously due to enough concentration of nutrients such as nitrogen and phosphorus (Bahati and Singh, 2003)

3.3. Minerals accumulation:

Table 6 and 7 illustrate the minerals element concentrations in stem and leaves of the two guar lines. The results revealed that generally, the concentrations of minerals for both lines stems and leaves tissues were of no consistent change as affected by the different treatments of wastewater concentrations.. This results may be attributed to the fact that metals uptake by plant is governed by many factors such as soil pH, organic matter (Eriksson,1996) temperature, soil microorganism, and plant species as well as the age of metal itself (Kennedy et al,1997). Several studies have demonstrated that pH is the most influential factor controlling sorption–desorption of heavy metals in soils and considered to be a primary factor influencing the phytoavailability of metals (Naidu et al,1994, Filius et al,1998). Sauve et al,(1998) reported that organic matter seems to have quite different effect on the trace metal uptake by crops, depending upon whether it is in soluble or insoluble form. Mench,., and. Martin.(1991) demonstrated that root exudates of Nicotina spp. The solubility of Zn was not, however, affected by the content of root exudates in the extracting solution in that experiment

Table 1: Physical and chemical characteristics of wastewater and well water

Parameter	wastewater	Well water
pH	6.33	7.00
TS	1600 mg/L	-
Na	9.20 mg/L	1.87 mg/L
K	1.20 mg/L	0.39 mg/L
Ca	0.25 mg/L	1.05 mg/L
Mg	2.55 mg/L	1.69 mg/L
Mn	0.08 mg/L	0.014 mg/L
Zn	0.09 mg/L	0.008 mg/L
Co	0.645 mg/L	0.072 mg/L
Fe	0.28 mg/L	0.150 mg/L
Cu	0.435 mg/L	0.029 mg/L
Cr	0.055 mg/L	0.020 mg/L
Pb	0.00mg/l	0.00 mg/L
Ni	0.08mg/L	0.03 mg/L

Table 2: Effect of different levels of wastewater on plant height (cm) of guar lines

Guar	Treated wastewater levels				
Lines	(0 %)	(25 %)	(50 %)	(75 %)	(100%)
L18	50.33 ^{b}	51.2 ^{b}	47.67 ^{bc}	49.53 ^{b}	59.67 ^{a}
L53	52.7 ^{b}	50.33 ^{b}	41.94 ^{c}	54.00 ^{b}	53.67 ^{b}

Values with the same superscript letters are not significantly different at $p < 0.05$ according to Duncan's multiple comparison tests

Table 3: Effect of different levels of wastewater on leaves numbers of guar lines

Guar			Treated wastewater levels		
Lines	(0 %)	(25 %)	(50 %)	(75 %)	(100%)
L18	10.17^{bc}	10.38^{bc}	9.58^{cd}	10.17^{bc}	10.44^{bc}
L53	11.08^{ab}	8.92^{d}	10.08^{bc}	11.11^{ad}	12.11^{a}

Values with the same superscript letters are not significantly different at $p < 0.05$ according to Duncan's multiple comparison tests

Table 4: Effect of different levels of wastewater on fresh weight (g) of guar lines

Guar			Treated wastewater levels		
Lines	(0 %)	(25 %)	(50 %)	(75 %)	(100%)
L18	18.02^{a}	16.06^{ab}	14.34^{bc}	15.44^{b}	19.68^{a}
L53	16.72^{b}	13.64^{bc}	11.56^{c}	14.14^{bc}	19.39^{a}

Values with the same superscript letters are not significantly different at $p < 0.05$ according to Duncan's multiple comparison tests

Table 5: Effect of different levels of wastewater on dry weight (g) of guar lines

Guar			Treated wastewater levels		
Lines	(0 %)	(25 %)	(50 %)	(75 %)	(100%)
L18	3.03^{ab}	2.85^{ab}	2.34^{bc}	2.52^{bc}	3.29^{a}
L53	2.99^{ab}	2.37^{bc}	1.92^{c}	2.46^{bc}	3.34^{a}

Values with the same superscript letters are not significantly different at $p < 0.05$ according to Duncan's multiple comparison tests

Table 6: Effect of different levels of wastewater on minerals content of guar lines stems

Guar Lines	Minerals	Treated wastewater levels (0 %)	(25 %)	(50 %)	(75 %)	(100%)
L18	Mn	5.4^{ab}	3.92^{b}	3.96^{b}	4.36^{b}	3.96^{b}
L53		3.8^{b}	3.76^{b}	6.64^{b}	4.14^{b}	4.16^{b}
L18	Zn	4.16^{c}	4.32^{c}	5.28^{c}	7.28^{a}	6.16^{b}
L53		4.96^{c}	4.6^{c}	6.52^{ab}	6.22^{b}	7.48^{a}
L18	Cu	9.52^{bc}	8.28^{c}	3.88d	7.56^{c}	11.7^{b}
L53		10.24^{b}	6.48^{c}	6.36^{c}	8.24^{c}	16.24^{a}
L18	Cr	$8.16^{a\,b}$	4.60^{b}	2.12^{b}	$9.32^{a\,b}$	8.12^{ab}
L53		15.76^{a}	3.68^{b}	8.64^{b}	7.76^{ab}	5.56^{b}
L18	Ni	3.76^{a}	5.52^{a}	1.52^{b}	1.24^{b}	3.72^{a}
L53		2.56^{b}	1.80^{b}	2.64^{b}	1.96^{b}	3.52^{a}

Values with the same superscript letters are not significantly different at $p < 0.05$ according to Duncan's multiple comparison tests

Table 7: Effect of different levels of wastewater on minerals content of guar lines leaves

Guar Lines	Minerals	Treated wastewater levels (0 %)	(25 %)	(50 %)	(75 %)	(100%)
L18	Mn	14.93^{a}	14.76^{a}	12.43^{a}	16.65^{a}	6.25^{a}
L53		17.8^{a}	11.7^{a}	18.05^{a}	16.13^{a}	13.35^{a}
L18	Zn	2.25^{d}	7.65^{ab}	6.38^{bc}	6.30^{bc}	6.38^{c}
L53		8.10^{a}	5.93^{c}	6.48^{c}	6.25^{c}	5.90^{c}
L18	Cu	2.13^{c}	5.15^{abc}	6.53^{a}	$6{,}02^{ab}$	7.48^{a}
L53		3.95^{bc}	5.43^{ab}	6.09^{b}	7.25^{a}	7.33^{a}
L18	Cr	6.15^{c}	7.8^{abc}	9.08^{ab}	8.6^{c}	6.35^{c}
L53		8.10^{ac}	10.18^{a}	6.58^{c}	8.03^{b}	$4{,}00^{d}$
L18	Ni	6.18^{a}	3.90^{b}	2.03^{c}	1.90^{c}	6.50^{a}
L53		4.18^{b}	2.90^{c}	2.90^{c}	2.93^{c}	1.70^{c}

Values with the same superscript letters are not significantly different at $p < 0.05$ according to Duncan's multiple comparison tests

Conclusion:

In conclusion, the development of guar crop was significantly affected by the application of wastewater. However the concentration of metals was of no consistent pattern in it leaves and stem. the ability of plant lines to accumulate metals as observed depends on wastewater concentration and the type of metal.. These results suggest that using treated wastewater at different concentration will benefit and not harm guar plant; however, the greater growth will be achieved with 100% concentration of the treated wastewater.

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