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Effect of Reed Grasses Treated Grey Water and Normal Water on Growth and Yield of Maize Crop

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Abstract: Reuse of grey water is gaining importance with the time because of multiple benefits. As safe disposal of wastewater has become one of the major problems in the countries like Pakistan. Through the reuse of grey water, the effluent will not only be safely disposed off, but it will be utilized for crop irrigation regularly. A study was conducted to observe the growth and yield of maize crop on grey water, treated grey water with three grass species including reed grass (Phragmites karka), reed mace (Typha elephantina), large sedge grass (Cyperus iria) and ground water. The reedbed system was installed at the Residential Colony of Sindh Agriculture University, Tandojam. The efficacy of reedgrass species and their effect on maize growth and production was evaluated. Results suggested that greater plant height (67.95 and 63.61 cm) and dry matter yield (26.47 and 22.35 g/pot) was recorded in maize crop irrigated with grey water passing P. karka and T. elephantina reed grass species, than C. iria specie. The untreated grey water was less useful as compared to normal irrigation water; while among reed grass species, the crop receiving grey water passing P. karka showed higher plant height and increased dry matter yield than the normal irrigation water as well as than T. elephantina and C. iria species. It is suggestible that P. karka showed most promising results in removal of grey water pollutants due to its dense tillering and morphological characteristics that treat the grey water effectively. The result for leaf N, P and K contents of maize irrigated with reedbed treated water indicated that leaf N content of maize was positively influenced by grey water irrigation. The untreated grey water resulted in the maximum leaf N content, followed by P. karka treated grey water; while almost equal leaf N content was observed in T. elephantina and C. iria treated grey water. Similar trends were observed in leaf P content of maize and it was positively and significantly affected by grey water irrigation. Untreated grey water resulted in maximum leaf P content, followed by P. karka and T. elephantina treated grey water; while the lowest leaf P content was observed under C. iria treated grey water. The leaf K content of maize was remarkably higher when the crop was irrigated with C. iria treated grey water, followed by T. elephantina treated grey water; while the lowest leaf K content was observed under P. karka treated grey water. On the basis of results on leaf K content of maize, it is suggested that C. iria grass could effectively be used for grey water recycling and to achieve crop higher leaf K content. The variation in nutrients showed association with the temperature variation during different months of the year as well as with the variation in the nutrient removal from grey water.

Keywords: Grey Water, Normal Water, Maize Crop

1. INTRODUCTION

Water scarcity is one of the elementary factors causing poverty among rural communities of Pakistan. Moreover, the sewage / grey water is used directly for crop production without treatment, which causes adverse effects on the crop, soil and humans that are the ultimate consumers of agriculture produce (IWMI, 2003; UN Report, 2003; Raza *et al.,* 2008). Any water that has been used in homes except toilets (i.e. water used in bathing, showering, dishwashing, sinks, laundry and other kitchen uses). Some estimates suggest this water comprises about 50 to 80 of total household wastewater used and is probably the greatest point source that can also be utilized (Christova-Boal *et al*., 1996; Eriksson *et al*., 2002; Jamrah *et al*., 2006). The wastewater from households may encompass variable undesirable loads of virus-prone bacteria those were generated during washing and laundering. This water may also hold oils, grease, fats, hair, lint, soaps, fabric softeners cleansers, and other chemicals. The limy or salty water contains higher levels of Cl^-, Na^+, borax, and SO_4^{-2} which are unsuitable for many florae. However, greywater is different from water generated from toilets commonly known as "Blackwater" which is extremely contaminated by pathogens and organic matters (Grey water Irrigation Guide, 2003).

The usage of household generated greywater for irrigation of small gardens around the homes, other open spaces, toilet flushing, groundwater recharge and industrial evaporative cooling are the attractive options and are increasing in both advanced and emerging countries to handle the problem of the water shortage. Various governments are providing useful guidelines on how to reuse of domestic greywater for irrigation and other usage. The government agencies are focusing on water management and regulation procedures. But, still there are many problems related to human, soil and plant health risks and environmental pollution by using greywater that need to be addressed. Also, public is anxious about the reuse of greywater for irrigation nearby their households. Therefore, there is need to re-examine public issues and pursue solutions to explicit recycling of greywater and establish guidelines using

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the site specific data to safeguard the sustainability of greywater recycle.

Kujawa and Zeeman, (2004) have explained the benefits of recycling of greywater. According to them, it is better source of water and contains minimum organic content. Greywater accounts up to about 70% of total water consumed and contains only 30% of the organic content and between 9 and 20% of the nutrients. Moreover, an individual households, can generate greywater that could support the amount of water needed for toilet flushing, car washing and garden watering (Karpiscak *et al*., 1990). For example, in the UK, on average, toilet flushing and outdoor water use represent 41% of total domestic water usage; greywater from showers, baths, hand basins, laundry and dishwashers correspond to 44% (Environment Agency, 2007). On a larger scale, other greywater can be used to irrigate parks, school yards, cemeteries and golf courses, fire protection and air conditioning systems(Lu and Leung, 2003).

Uses of treated greywater for irrigation of nearby household gardens, sprinkling park and open spaces, toilet flushing, groundwater recharge and cooling of industrial machinery have been documented in the literature (Okun, 1997; Ottoson and Stenstrom, 2003). In arid regions, a substantial portion of greywater can meet the water demands of nearby house gardens (Manios *et al*., 1991). Reuse of this water can save fresh water supplies. It have documented that about 30 to 50% saving of fresh water could be achieved when greywater is reused for toilet flushing and irrigation (Jeppesen, 1996).

No noteworthy dissimilarities in total soil N were observed for any of the treatments after harvest even though soil was irrigated with 100% greywater that had greater total as compared to control. The N values of soil irrigated with greywater ranged between 290 and 394 mg/kg, and were similar (385 mg/kg) to those previously detected by Wiel-Shafran *et al*. (2006) for greywater irrigation used in lettuce. Wiel-Shafran *et al*. (2006) found that buildup of N in the soil is interrelated to the concentrations present in the greywater. Alike to total N loads, the total P, after harvest, was also not considerably predisposed for any of the treatments by any of treatment as compared to control. Thus, it is obvious that alternate irrigation with potable and greywater could further reduce the risks linked with the reuse of greywater. The quantity of total N and total P accrued in soil was related to the detergents applied. Wide variation in N and P loads has been reported in the past studies when greywater from laundry sources was used. Christova-Boal *et al*. (1996) informed the total N and P values ranged between 1 and 40 mg/kg and 0.062 and 42 mg/kg, respectively, whereas De Clercka *et al.* (2003) reported those values ranged between 3.5 and 31 mg/kg and 0.2 and 93 mg/kg, respectively. This variation is attributed to the type of detergent used. The values of the total N (0.21 mg/kg) and total P (4.42 mg/kg) in 100% greywater, lied on the lesser side of the array reported in the above studies.

The water that is produced from sinks, showers and washing machines, but does not include toilet water, is considered as grey water. It includes traces of dirt, soap, food, grease or hair, it may be safe to use for irrigation after treatment locally. The reedbed technology, low cost and easy disposal of grey water, can supplement the water demand for urban and agricultural use.

2. MATERIAL AND METHODS

The experiments were conducted for a consecutive period of two years (2013 and 2014) under agro-ecological conditions of Tandojam, District Hyderabad, Sindh (Pakistan), located at 25°25' 60'N 68^{0}31' 60E 19.5 m asl.

Study location and treatments

The study on grey water treatment using reedbed technology was carried out at new residential colony, Sindh Agriculture University Tandojam.Treatments under study include following three different grass species which were grown in three replicated reedbeds at the experimental site.

Treatments (reed grass species)

T0 = Grey Water; T1 = Reed grass (*Phragmites karka*) locally called "NUR" (irrigated with grey water); T2 = Reed mace : (*Typha elephantina)* locally called "Pann" (irrigated with grey water); T3 = Large sedge grass *(Cyperis irria*) locally called "Kall" (irrigated with grey water) and T4 = Ground water

Separation of Grey water from Mixed Sewage

The grey water from the 10 selected houses was collected by installing separate plumbing system for the houses considered for experiment. The collected grey water then were stored in a tank and was supplied separately to the reedbeds for purification.

Maize crop was used as the test crop to investigate the crop responses to purified water by the reedbed system using three different reed grass species. The maize crop was planted in pots during spring and autumn cropping seasons consecutively during 2013 and 2014 years. Hence, the maize crop was tested for its response to grey water quality parameters during four cropping seasons.

3. RESULTS

The studies were carried out for two consecutive years with the main objectives to observe the agronomic parameters of maize crop.

Plant height (cm)

The effect of grey water treated with different reed grass species (*Phragmites karka*, *Typha elephantina* and *Cyperus iria*)as compared to untreated grey water and normal water on plant height of test crop maize was investigated for four cropping seasons (spring and autumn) during 2013 and 2014. The analysis of variance showed that plant height was significantly affected by irrigation water treatments with different reed grass species (DF=4, F=88.00, P=0.000), cropping seasons (DF=1, F=39.75, P=0.000), years (DF=1, F=128.39, P=0.000) and reed grass species × cropping seasons (DF=4, F=2.85, P=0.0370).

The data **(Table 1)** showed that the plant height of maize during autumn and spring of 2013 was 58.45 and 63.12 cm (av: 60.79 cm); while during 2014 it was 65.20 and 65.75 cm (av: 65.47 cm). It was observed that the plant height of maize was relatively higher during spring as compared to autumn season. Moreover, the maize plant height was higher during 2014 (65.47 cm) as compared to 2013 (60.79 cm).

The effect of grey water treatment by various reed grass species on maize plant height indicated that plant height of maize irrigated with grey water passing *Phragmites karka* was inceased over normal irrigation and decreased when passing through *Typha elephantina* and *Cyperus iria* reed grass species significantly, but yet higher than the untreated grey water. The two years average plant height of maize irrigated with normal water and untreated grey water was 66.46 and 57.47 cm, while 67.95 and 63.61 cm plant height recorded in maize crop irrigated with grey water passing *Phragmites karka* and*Typha elephantina* reed grass species, respectively; while the plant height of 60.17 cm was observed in maize crop irrigated with grey water passing *Cyperus iria* reed grass species.

The results showed that grey water (untreated) was less useful as normal irrigation water; while among reed grass species, the crop receiving grey water passing *Phragmites karka* showed maize plant height performance more than the normal irrigation water as wll as from other treatments. However, the crop performance in regards to plant height was relatively poor when irrigated with untreated grey water or when grey water passing *Typha elephantina* and *Cyperus iria* reed grass species. Hence, the grey water treatment with *Phragmites karka* reed grass proved to be most effective organically recycling treatment of the grey water.

Table 1. Impact of Grey Water treatment with different reed Grass Species on the plant height (cm) of autumn and spring sown maize during 2013 and 2014

Treatments	2013			2014			Overall mean
	Autumn	Spring	Mean	Autumn	Spring	Mean	
T0=Normal water (control)	61.33	67.1	64.22 b	68.43	68.97	68.70 a	66.46
T1= Treated with *Phragmites karka*	64.71	67.86	66.29 a	69.2	70.02	69.61 a	67.95
T2= Treated with *Typha elephantina*	58.77	64.17	61.47 c	65.1	66.41	65.76 b	63.61
T3= Treated with *Cyperus iria*	56.64	58.18	57.41 d	63.46	62.39	62.93 c	60.17
T4= Grey water (untreated)	50.8	58.3	54.55 e	59.83	60.94	60.39 d	57.47
Mean	58.45	63.12	60.7960.79	65.20	65.75	65.47	64.44

	Treatments(T)	Seasons(S)	Years (Y)	T×S	T×Y	T×S×Y
S.E.±	0.6542	0.4138	0.4138	0.9253	0.9253	1.3086
LSD 0.05	1.3246	0.8377	0.8377	1.8732	NS	NS

Dry matter yield (g/pot)

The effect of grey water treatment with *Phragmites karka*, *Typha elephantina* and *Cyperus iria* reed grass species on dry matter yield of maize as compared to untreated grey water and normal water was assessed for spring and autumn seasons during two consecutive years (2013 and 2014). The analysis of variance demonstrated that dry matter yield was significantly influenced by irrigation water treatments with different reed grass species (DF=4, F=160.63, P=0.000), cropping seasons (DF=1, F=43.98, P=0.000) and years (DF=1F=115.45, P=0.000); while non-significant (P>0.05) for reed grass species × cropping seasons (DF=4, F=1.89, P=0.1321).

The data **(Table 2)** showed that the dry matter yield of maize during autumn and spring of 2013 was 22.12 and 23.30g/pot (avg 22.71g/pot); while during 2014 it was 24.08 and 25.42g/plot (avg 24.75g/pot). The dry matter yield of maize was relatively higher during spring than the dry matter yield obtained in the maize sown autumn. Similarly, the maize dry matter yield was higher during year 2014 (24.75 g/pot) than the dry matter yield in 2013 (22.71g/pot).

The influence of grey water treatment on maize dry matter yield showed that the dry matter yield of maize irrigated with grey water passing *Phragmites karka*, *Typha elephantina* and *Cyperus iria*during 2013 was 26.96, 20.44 and 22.13 g/pot; while during 2014 it was 28.37, 22.32 and 23.97 g/pot which showed a appreciable increase over normal irrigation water or untreated grey water. During 2013, the dry matter yield under normal water and untreated grey water was 23.73 and 20.31g/pot; while during 2014 it was 26.47 and 22.35 g/pot, respectively. The two years average dry matter yield of maize irrigated with untreated grey water (21.33 g/pot) and *Typha elephantina* treated water (21.38 g/pot); while highest dry matter yield of 27.68 g/pot was recorded when the crop was irrigated with *Phragmites karka*.

It was observed that grey water treated with *Phragmites karka* was highly beneficial irrigation source for maize that resulted in higher dry matter yield than the normal water, untreated grey water as well as grey water passing other reedgrass species. Hence, the grey water treatment with *Phragmites karka* reed grass showed most promising results when supplied to test crop for dry matter yield and this reed grass species could be suggested for recycling of grey water at reedbed.

Table 2. Impact of grey water treatment with different reed grass species on the dry matter yield (g/pot) of autumn and spring sown maize during 2013 and 2014

Treatments	2013			2014			Overall mean
	Autumn	Spring	Mean	Autumn	Spring	Mean	
T0=Normal water (control)	24.06	23.39	23.73 b	27.19	25.74	26.47 b	25.10
T1= Treated with *Phragmites karka*	27.43	26.49	26.96 a	28.93	27.8	28.37 a	27.66
T2= Treated with *Typha elephantina*	20.81	20.06	20.44 d	22.44	22.2	22.32 d	21.38
T3= Treated with *Cyperus iria*	22.98	21.27	22.13 c	24.58	23.36	23.97 c	23.05
T4=Grey water (untreated)	21.22	19.4	20.31 d	23.38	21.32	22.35 d	21.33
Mean	22.12	23.3	22.71	24.08	25.42	24.75	23.73

	Treatments(T)	Seasons(S)	Years (Y)	T×S	T×Y	T×S×Y
S.E.±	0.3003	0.1899	0.1899	0.4247	0.4247	0.6007
LSD 0.05	0.6080	0.3845	0.3845	NS	NS	NS

Leaf N content (%)

The leaf N content of test crop maize was determined to assess the effect of grey water passing *Phragmites karka*, *Typha elephantina* and *Cyperus iria* reed grass species on leaf N content and compared with untreated grey water and normal water. The analysis of variance demonstrated that leaf N content was significantly affected by irrigation water treatments with different reed grass species (DF=4, F=16.90, P=0.000) and cropping seasons (DF=1, F=6.33, P=0.0162); while non-significant (P>0.05) for years (DF=1, F=3.18, P=0.0825) as well as the interactive effect of reed grass species × cropping seasons (DF=4, F=0.28, P=0.8869). The leaf N content of maize **(Table-3)** during autumn and spring of 2013 was 3.47 and 3.76%; while during 2014 it was 3.68 and 3.92%. The leaf N content of maize was relatively higher during spring than the leaf N content determined in the autumn sown maize. Moreover, the maize leaf N content was higher during 2014 (3.80%) than the leaf N content in 2013 (3.62%).

The impact of grey water treatment on leaf N content indicated that the leaf N content of maize irrigated with grey water passing *Phragmites karka*, *Typha elephantina* and *Cyperus iria* during 2013 was 3.99, 3.34 and 3.88% against 2.86% under normal water and 4.03% in untreated grey water treatment, respectively; while in 2014 it was 4.19, 3.40 and 3.84% against 3.28% under normal water and 4.31% under untreated grey water treatment. The two years average leaf N content of maize was relatively higher when irrigated with untreated grey water (4.17%), by *Phragmites karka*, *Cyperus iria*and *Typha elephantina* treated water with average leaf N of 4.09, 3.86 and 3.37%, respectively; while the lowest leaf N (3.07%) was determined in control (normal water). The results indicated that the leaf N content of maize was positively influenced by grey water irrigation and untreated grey water resulted in maximum leaf N content, followed by *Phragmites karka* treated grey water; while almost equal leaf N content was observed in case of *Typha elephantina* and *Cyperus iria* treated grey water.

Table 3. Impact of Grey Water Treatment with different Reed Grass Species on the leaf N content (%) of autumn and spring sown maize during 2013 and 2014

Treatments	2013			2014			Overall mean
	Autumn	Spring	Mean	Autumn	Spring	Mean	
T0=Normal water (control)	3.22	2.49	2.86 c	3.31	3.25	3.28 c	3.07
T1= Treated with *Phragmites karka*	4.08	3.9	3.99 a	4.28	4.09	4.19 a	4.09
T2= Treated with *Typha elephantina*	3.4	3.28	3.34 b	3.5	3.29	3.40 c	3.37
T3= Treated with *Cyperus iria*	3.99	3.77	3.88 a	4.11	3.56	3.84 b	3.86
T4= Grey water (untreated)	4.11	3.95	4.03 a	4.39	4.23	4.31 a	4.17
Mean	3.47	3.76	3.62	3.68	3.92	3.80	3.71

	Treatments(T)	Seasons(S)	Years (Y)	T×S	T×Y	T×S×Y
S.E.±	0.1640	0.1037	0.1037	0.2319	0.2319	0.3280
LSD 0.05	0.3320	0.2100	NS	NS	NS	NS

Leaf P content (%)

The effect of grey water treated with *Phragmites karka*, *Typha elephantina* and *Cyperus iria* grass species on the leaf P content of maize was examined and compared with untreated grey water and normal water. The analysis of variance suggested that leaf P content was significantly influenced by grey water treated with varying reed grass species (DF=4, F=10.06, P=0.000)while non-significantly affected due to cropping seasons (DF=1, F=0.10, P=0.7547); years of study (DF=1, F=0.01, P=0.9377) as well as the interactive effect of reed grass species × cropping seasons (DF=4, F=0.22, P=0.9262).

The leaf P content of maize **(Table-4)** during autumn and spring of 2013 was 0.33 and 0.34%; while during 2014 it was 0.35 and 0.33% . The leaf P content of maize was relatively higher during spring than the leaf P content determined in the autumn sown maize. Moreover, the maize leaf P content was equal during 2013 (0.34%) and 2014 (0.34%).

The results showed that the leaf P content of maize irrigated with grey water passing *Phragmites karka*, *Typha elephantina* and *Cyperus iria* during 2013 was 0.34%, 0.34% and 0.33% against 0.28% under normal water and 0.36% in untreated grey water, respectively; while in 2014 it was 0.36%, 0.34% and 0.34% against 0.29% under normal water and 0.38% under untreated grey water, respectively. The two years average leaf P content of maize was the highest when irrigated with untreated grey water (0.37%), followed by *Phragmites karka*, *Typha elephantina* and *Cyperus iria* treated water with average leaf P of 0.35%, 0.34% and 0.34%, respectively; while the lowest leaf P (0.29%) was analysed in normal water (control).

It is evident from the results that that the leaf P content of maize was positively and significantly affected by grey water irrigation and untreated grey water resulted in maximum leaf P content, followed by *Phragmites karka* and *Typha elephantina* treated grey water; while the lowest leaf P content was observed in case of *Cyperus iria* treated grey water.On the basis of results on leaf P content of maize, it is suggested that *Phragmites karka* reed grass could effectively be used for grey water recycling in the reedbed.

Table 4. Impact of Grey Water treatment with different Reed Grass Species on the leaf P content (%) of Autumn and spring sown maize during 2013 and 2014

Treatments	2013			2014			Overall mean
	Autumn	Spring	Mean	Autumn	Spring	Mean	
T0=Normal water (control)	0.31	0.28	**0.30 c**	0.28	0.29	**0.29 c**	**0.29**
T1= Treated with *Phragmites karka*	0.35	0.34	**0.35 a**	0.35	0.36	**0.36 a**	**0.35**
T2= Treated with *Typha elephantina*	0.34	0.34	**0.34 b**	0.32	0.36	**0.34 b**	**0.34**
T3= Treated with *Cyperus iria*	0.35	0.33	**0.34 b**	0.31	0.36	**0.34 b**	**0.34**
T4=Grey water (untreated)	0.37	0.36	**0.37 a**	0.37	0.38	**0.38 a**	**0.37**
Mean	**0.33**	**0.34**	**0.34**	**0.35**	**0.33**	**0.34**	**0.34**

	Treatments(T)	Seasons(S)	Years (Y)	T×S	T×Y	T×S×Y
S.E.±	0.0134	0.0084	0.0084	0.0189	0.0189	0.0268
LSD 0.05	0.0271	NS	NS	NS	NS	NS

Leaf K content (%)

The impact of grey water treated with *Phragmites karka*, *Typha elephantina* and *Cyperus iria* grass species on the leaf K content of test crop maize was determined and compared with untreated grey water and normal water. The analysis of variance demonstrated that leaf K content was significantly influenced by grey water treated with varying reed grass species (DF=4, F=5.63, P=0.0012), cropping seasons (DF=1, F=4.85, P=0.0.0338) andyears of study (DF=1, F=9.19, P=0.0044)while non-significantly affected due to interactive effect of reed grass species × cropping seasons (DF=4, F=1.59, P=0.1970).

The results **(Table-5)** showed that the leaf K content of maize during autumn and spring of 2013 was 4.58 and 4.38% ; while during 2014 it was 5.18 and 4.70% . The leaf K content of maize was higher during spring than the leaf K content in the autumn sown maize. Similarly, the maize leaf K content was higher during 2014 (4.94%) than the leaf K content in 2013 (4.48%).

It was further observed that the leaf K content of maize irrigated with grey water passing *Phragmites karka*, *Typha elephantina* and *Cyperus iria* during 2013 was 4.84%, 4.91% and 4.45% against 3.48% under normal water and 4.73% in untreated grey water, respectively; while in 2014 it was 5.25%, 4.75% and 4.78% against 3.70% under normal water and 5.30% under untreated grey water, respectively. The two years average leaf K content of maize was highest when irrigated with *Phragmites karka* grey water (5.04%), followed by untreated grey water (5.01%), *Typha elephantina* treated grey water (4.83%) and *Cyperus iria* treated treated grey water (4.62%); while the lowest leaf K content of 3.59% was determined in maize irrigated by normal water (control).

The results indicated that leaf K content of maize was remarkably higher when the crop was irrigated with *Phragmites karka* treated grey water, followed by *Typha elephantina* treated grey water; while the lowest leaf K content was observed in case of *Cyperus iria* treated grey water. On the basis of results on leaf K content of maize, it is suggested that *Phragmites karka* reed grass could effectively be used for wastewater recycling in the reedbed in regards to achieve crop with higher leaf K content.

Table 5. Impact of Grey Water Treatment with different Reed Grass species on the leaf K content (%) of Autumn and Spring sown maize during 2013 and 2014

Treatments	2013			2014			Overall mean
	Autumn	Spring	Mean	Autumn	Spring	Mean	
T0=Normal water (control)	3.35	3.61	**3.48 b**	3.74	3.65	**3.70 c**	**3.59**
T1= Treated with *Phragmites karka*	4.75	4.92	**4.84 a**	4.99	5.51	**5.25 a**	**5.04**
T2= Treated with *Typha elephantina*	4.86	4.96	**4.91 a**	4.44	5.06	**4.75 b**	**4.83**
T3= Treated with *Cyperus iria*	4.26	4.64	**4.45 a**	4.86	4.7	**4.78 b**	**4.62**
T4= Grey water (untreated)	4.68	4.77	**4.73 a**	5.49	5.11	**5.30 a**	**5.01**
Mean	**4.58**	**4.38**	**4.48**	**5.18**	**4.7**	**4.94**	**4.71**

	Treatments(T)	Seasons(S)	Years (Y)	T×S	T×Y	T×S×Y
S.E.±	**0.2415**	**0.1527**	**0.1527**	**0.3415**	**0.3415**	**0.4830**
LSD 0.05	**0.4889**	**0.3092**	**0.3092**	**NS**	**NS**	**NS**

4. DISCUSSION

The effect of grey water treated with different reed grass species (*Phragmites karka*, *Typha elephantina* and *Cyperus iria*) as compared to untreated grey water and normal water on agronomic performance of mazie for four cropping seasons was significant (P<0.05). During 2013 and 2014 greater plant height (67.95 and 63.61 cm) and dry matter yield (26.47 and 22.35 g/pot) was recorded in maize crop irrigated with grey water passing *Phragmites karka* and *Typha elephantina* reed grass species, than rest of the treatments. The grey water (untreated) was less useful as normal irrigation water; while among reed grass species, the crop receiving grey water passing *Phragmites karka* showed maize plant height and dry matter yield performance more than the normal irrigation water as wll as from other treatments. However, the crop performance in regards to plant height was relatively poor when irrigated with untreated grey water or when grey water passing *Typha elephantina* and *Cyperus iria* grass species. Hence, the grey water treatment with *Phragmites karka* reed grass proved to be most effective organically recycling treatment of the grey water. Similar results have also been reported by Halalsheh *et al.*, (2008); Madungwe *et al.,* 2007); Sheikh *et al.* (2005); Moir *et al.* (2005); Ross Mars (2005); Kujawa and Zeeman *(*2004) Lu and Leung (2003). The consolidated findings as assessed from the results of the above studied clearly indicated that reedbed technology removed the heavy metal concentrations of the grey water and beneficially irrigated their test crops under reeed grass treated water. Their findings also suggested that *Phragmites karka* showed most promising results regarding grey water pollutants removal due to its dense tillering and morphological characteristics to treat the effluent water.

The effect of reed grass species on leaf N, P and K content in maize irrigated with reedbed treated water indicated that leaf N content of maize was positively influenced by grey water irrigation and untreated grey water resulted in maximum leaf N content, followed by *Phragmites karka* treated grey water; while almost equal leaf N content was observed in case of *Typha elephantina* and *Cyperus iria* treated grey water. The leaf P content of maize was positively and significantly affected by grey water irrigation and untreated grey water resulted in maximum leaf P content, followed by *Phragmites karka* and *Typha elephantina* treated grey water; while the lowest leaf P content was observed in case of *Cyperus iria* treated grey water. The leaf K content of maize was remarkably higher when the crop was irrigated with *Cyperus iria* treated grey water, followed by *Typha elephantina* treated grey water; while the lowest leaf K content was observed in case of *Phragmites karka* treated grey water. On the basis of results on leaf K content of maize, it is suggested that *Cyperus iria* reed grass could effectively be used for wastewater recycling in the reedbed in regards to achieve crop with higher leaf K content. The variation in nutrients showed association with the temperature variation during different months of the year as well as with the variation in the nutrient removal from grey water. These results are further confirmed by Halalsheh *et al.,* (2008) who were of the experience that recycling greywater is one of the possible options to meet the urban water demands and the irrigation needs and essentially needed N, P and K nutrients were relatively higher in treated grey water as compared to commonly used canal irrigation water (Madungwe *et al.,* 2007).

5. CONCLUSIONS

Following conclussions have been drawn from the study.

- So far the agronomic performance of maize crop is concerned, the plant height and dry matter yield was relatively poor when irrigated with untreated grey water or when grey water passing *Typha elephantina* and *Cyperus iria* reed grass species.Hence, the grey water treatment with *Phragmites karka* reed grass proved to be most effective organically recycling treatment of the grey water
- The grey water treatment with *Phragmites karka* reed grass showed most promising results when supplied to test crop for dry matter yield and this reed grassspecies could be suggested for recycling of grey water at reedbed.
- The leaf N and P content of maize was positively influenced by grey water irrigation and untreated grey water resulted in maximum leaf N content, followed by *Phragmites karka* treated grey water; while almost equal leaf N content was observed in case of *Typha elephantina* and *Cyperus iria* treated grey water. On the basis of results on leaf P content of maize, it is suggested that *Phragmites karka* reed grass could effectively be used for grey water recycling in the reedbed.
- The leaf K content of maize was remarkably higher when the crop was irrigated with *Phragmites karka* treated grey water, followed by *Typha elephantina* treated grey water; while the lowest leaf K content was observed in case of *Cyperus iria* treated grey water. On the basis of results on leaf K content of maize, it is suggested that *Phragmites karka* reed grass could effectively be used for wastewater recycling in the reedbed in regards to achieve crop with higher leaf K content.
- Grey water treated through Reedbed technology remained useful for its effective utilization to meet the water demand for urban and agricultural use.

Suggestions / Recommendations

Phragmites karka can show most promising results for the treatment of grey water through reedbed technology as compared to other indigenous grass species with following recommendations.

1. The *phrgramites karka* can successfully be used for the treatment of grey water containing domestic water pollutants.

2. Grey water treated through reedbed technology can be useful for domestic gardening and toilet flushing to meet water demand for urban and agricultural use.

3. Such type of technology may be launched to provide treated grey water for vegetable and fodder production on commercial basis.

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