IMPACT OF SEWAGE WATER OF MEERUT CITY ON THE GROWTH AND YIELD COMPONENTS OF WHEAT (*TRITICUM AESTIVUM* L.)

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Abstract: A pot experiment was conducted in the winter season 2008-09 to evaluate the suitability of sewage wastewater of Meerut city as a source of irrigation due to some essential plant nutrients and its impact on growth and yield components of three wheat cultivars *viz.* PBW 343, PBW 373 and UP 2338. The test crop was raised with different concentrations of sewage water (T_1 : 10 %, T_2 : 25 %, T_3 : 50 %, T_4 : 75 %, T_5 : 100 %) compared to control plants (T_0) receiving normal ground water. Wastewater promoted growth, number of tillers, number of ears, total chlorophyll, 1000 seed weight, seed yield, biological yield and harvest index as compared to control. Physicochemical characteristics of sewage water met the prescribed irrigation quality requirement and were within the permissible limit of Indian standard. 50 % sewage water was found most suitable for the measured growth parameters while higher concentration proved inhibitory. Sewage water may be considered as an alternative of fresh water for irrigation purpose improving yield and quality of wheat crop.

Keywords: Chlorophyll content, growth, sewage water, yield and harvest index

INTRODUCTION

Sustainable agricultural development is influenced to a great extent by sources of water that might be used economically and effectively in developing agriculture programs. Therefore, the use of treated municipal wastewater, as a new source for water irrigation, has been encouraged by Indian government to increase the efficient use of water irrigation in crop production. The use of wastewater for irrigation has the additional benefit of environmental protection (Pescod, 1992).

Treated wastewater is being used in many countries throughout the world as a reliable source of water which can fulfill the gap between supply and demand in water sector (Oron *et al.*, 2007). Advancement in the effectiveness and reliability of wastewater treatment technologies have improved the capacity to produce recycled water that can serve as an alternative water source in addition to meeting water quality protection and abatement requirement (Lozarova, 2000; Papadopoulos and Savvides, 2003; Camargo *et al.*, 2007).

Wastewater is recognized to have direct effect on soil chemical properties. When wastewater will be used continuously as the sole source of irrigation water for field crops, excessive amounts of nutrients and toxic chemical substances could simultaneously be applied to the soil plant system. This would cause unfavourable effects on productivity and quality parameters of the crops and the soil (Vazquezmontiel *et al.*, 1996).

Heavy metals such as copper, cadmium, chromium, lead, mercury and selenium get into water from many source, including industries, automobile exhaust, mines and even from natural soil (Al-Nakshabandi *et al.,* 1997; Faryal *et al.,* 2007; Khan *et al.,* 2008). Plants grown in contaminated soils or irrigated with municipal wastewater when consumed by people can result in health problems (Papadopoulos and Stylianous, 1991; Wahid *et al.,* 2004) like diarrhea, mental retardation, liver and kidney damage (Matsuno *et al.,* 2004; Uzair *et al.,* 2009).

Some work has been done on the effect of different source of industrial effluent on the germination and growth of pulses, millets, cereals and fodder etc. (Muthuchelian *et al.*, 1988; Vijay Kumari *et al.*, 1993; Jabeen and Abraham, 1997; Iqbal and Mehta, 1998). Thus owing to the beneficial utility of wastewater in augmenting crop productivity vis-à-vis proper disposal option, we planed to study the feasibility of treated sewage water in relation to NPK fertilizer economy and productivity of wheat crop.

MATERIAL AND METHOD

Experimental site : Present experiment was conducted in the Department of Botany, Kisan (P.G.) College, Simbhaoli (Ghaziabad) during 2008-09 growth season. The soil used for this experiment was sandy loam with slightly acidic pH (6.7), organic carbon 0.3 % and water holding capacity 15 %. The available N, P and K were 98, 18 and 21 kg/ha respectively.

Source of seeds : Fresh lot of certified seeds of three wheat cultivars PBW 343, PBW 373 and UP 2338 were obtained from National Seed Corporation, Meerut.

Source of wastewater : Wastewater was collected from the sewage pump station, Shastrinagar, Meerut. These effluents were collected only once before the commencement of each growth season in a sufficient quantity, stored in shade and then its different concentrations were supplied to the test plants in pots. Fresh dilutions were made before each irrigation.

Wastewater analysis : Wastewater effluents collected from sewage pump were analyzed for various parameters of water quality analysis at Environment Science Laboratory, C.C.S. University, Meerut.

Experiment design : Thick polythene bags (25 cm diameter) were used for growing test wheat cultivars. Soil was mixed with cow dung in a 10 : 1 ratio. Approximately 5 kg soil mixture was filled in each bag. There were six effluent treatments *viz.* T_0 (normal ground water or control), T_1 (10 % polluted water), T_2 (25 % polluted water), T_3 (50 % polluted water), T_4 (75 % polluted water) and T_5 (100 % or non diluted polluted water) used for three cultivars of wheat. For each cultivar, there were five replicate bags within each treatment leading to a total of 30 bags. The bags were labeled according to their respective treatment, replicate and cultivars, to record the data with accuracy.

Raising the crop : Ten seeds were sown at equidistant places in each polythene bag on 1st December 2008. After complete germination, the number of seedlings per bag was reduced to five by manual thinning in each bag. Bags were watered with known quantity of wastewater regularly as and when required throughout the growth season. The test plants were raised following normal agronomical practices with two fertilizer doses $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$.

Recording the data : The various growth parameters were recorded from 5 randomly selected plants in each treatment at 30, 60, 90 and 120 days after sowing. Total chlorophyll content was determined following Arnon (1949). Yield attributes were recorded at harvest.

RESULT AND DISCUSSION

Physicochemical properties of sewage water used for raising the wheat crop are given in Table 1. As compared with ground water, the wastewater is slightly alkaline, possesses a comparatively higher value of BOD and COD and contained higher amounts of NPK, Ca^{2+}, Na^{+}, Cl^{-} and CO_3^{2-} The Bureau of Indian Standard (BIS) has recommended various standards for the disposal of industrial wastewaters. The tolerance limits prescribed by the BIS for wastewater discharged on land are: pH 5.9-9.0, total solids 2100 mg L^{-1}, chlorides 600 mg L^{-1}, BOD 500 mg L^{-1}. It is evident from Table 1 that the values of all these parameters of the wastewater used in the present study are within the tolerance limit. On the other hand concentration of several inorganic ions was higher in sewage water than in ground water, of these NO_3, PO_4, K, Ca, Mg being essential for plant growth, a higher value of these elements in wastewater could be considered beneficial. The role of these macro nutrients particularly calcium and magnesium in maintaining the soil health is no less important.

In the present study data on the seed germination percentage revealed that germination percentage has been observed maximum in 50 % concentration of sewage water with $N_{50}P_{40}K_{20}$ fertilizer level (Figs. 1a & b). The effect of different treatments (10 %, 25 %, 50 %, 75 % and 100 %) alongwith two fertilizers level : $N_{50}P_{40}K_{20}$ and $N_{100}P_{80}K_{40}$ have been observed on the different growth attributing characters such as plant height, chlorophyll content, number of tillers, number of ears, 1000 seed weight, days to 50 % flowering and days to maturity of *Triticum aestivum* cvs. PBW 343, PBW 373 and UP 2338. Plant height has been revealed slightly promontory in 50 % of sewage water under the fertilizer level $N_{50}P_{40}K_{20}$ and inhibitory in 100 % sewage water non-diluted (Table 2, Figs. 2a & b). Our findings are in the confirmation with that of Nagaraja and Krishnamurti (1988). Symptoms of the chlorophyll degradation have been observed in the form of yellowish leaf in the higher concentration of sewage water and fertilizer level of $N_{100}P_{80}K_{40}$. However, effluent of lower dose (50 %) of waste water has been manifested in the form of higher chlorophyll content (Figs. 3a & b). The observed enhancement as in photosynthetic pigments and morpho-physiological attributes has also been reported by Aziz *et al.* (1993), Karunyal *et al.* (1994) and Adhikari and Gupta (2002).

Yield is the final manifestation of physiological, morphological and biological trait of a crop. The availability of essential nutrients in the sewage water as well as in soil supplied in inorganic form and the acquisition by the growing plant lead to formation of more reproductive part, which cumulatively are responsible for higher seed yield. The present data also confirm the earlier finding while applying industrial wastewater on different crops (Aziz *et al.*, 1999; Hayat *et al.*, 2000).

Figs. 4 to 9 represent the data and yield parameters of the wheat crop due to wastewater treatment. There was significant increase in the number of tillers, number of ears and grain yield. These result corroborate the findings of Tsadilas (1999) and Tsadilas and Vakalis (2003) who found increased yield of maize irrigated with treated wastewater. Brady and Weil (2008) observed the increment in plant growth due to the presence of high organic matter in the treated liquid fertilizer (treated effluent). Generally, it is suggested that increase in the wheat yield result in following items:

(i) Increase of treated wastewater application rate causing higher nutrient input (Overman, 1981).

(ii) Higher uptake and accumulation of phosphorus (Vazquez-Montiel *et al.*, 1996).

(iii) Occurrence of macro and micro nutrients in the effluent which can neutralize the undesirable effect of high Na concentration in treated wastewater (Al-Jaloud *et al.*, 1995).

Yield parameters like days to 50 % flowering, days to maturity (Table 3), 1000 seed weight, harvest index and biological yield register the higher values in 50 % sewage water under the fertilizer level $N_{50}P_{40}K_{20}$. Similar results have been recorded by Pradhan *et al.* (2001) and Akhter *et al.* (2006). However, Kakar *et al.* (2010) reported a marked decrease in chlorophyll a, chl b, number of siliqua per plant, seeds per plant, seed weight per plant and the harvest index in Oskar and Rainbow cultivars of Canola grown in soil irrigated with municipal wastewater of Quetta city.

Soil is sandy loam. For wastewater discharged by many industrial units, the general belief is that continuous irrigation with such wastewater deteriorates the quality of soil because the use of such wastewater over year may result in reduced infiltration rate and pore space which directly effects the movement of air and water in the soil. In the present study, however, no significant change in the quality of soil was observed as a result of irrigation of sewage water. Thus it may be concluded that the soil did not retain excessive amount of salt during the experimental period. Sewage water may be considered as an alternative of fresh water for irrigation purpose in improving yield and quality of wheat crop.

Table 1. Physicochemical Characteristics of sewage water and ground water with different parameters.

Sl.	Parameters	Sewage Water	Ground Water
1	pH	7.86	7.5
2	Hardness	560 ppm	220 ppm
3	TDS	1050 mg^{-1}	468 mg^{-1}
4	TSS	1223 mg^{-1}	325 mg^{-1}
5	COD	248.6 mg^{-1}	37.35 mg^{-1}
6	BOD	164.2 mg^{-1}	15.85 mg^{-1}
7	Temperature	15.5^{0}C	15.0^{0}C
8	Colour	Slight yellowish	Colourless
9	Odour	Unpleasant	Odourless
10	E.C. (Electrical conductivity)	1160 μmhos cm^{-1}	615 μmhos cm^{-1}
11	DO	2.8 mg^{-1}	2.3 mg^{-1}
12	Ca	70.30 mg^{-1}	25.72 mg^{-1}
13	K	36.14 mg^{-1}	7.26 mg^{-1}
14	Na	86.55 mg^{-1}	15.3 mg^{-1}
15	Cl	199.4 mg^{-1}	69.83 mg^{-1}
16	CO_3	165.48 mg^{-1}	20 mg^{-1}
17	PO_4	3.36 mg^{-1}	Nil
18	Mg	37.11 mg^{-1}	18 mg^{-1}

Table 2. Effect of sewage water on plant height (cm) of Triticum aestivum L. with fertilizer dose at N_{100} P_{80} K_{40} and N_{50} P_{40} K_{20}

$N_{100}P_{80}K_{40}$

Cultivar	Days	T_0	T_1	T_2	T_3	T_4	T_5
PBW 343	30	28.75±0.448	29.00±1.155	32.00±0.850	28.95±0.117	22.50±0.598	18.92±0.295
	60	72.39±1.923	72.50±0.293	75.00±2.988	72.50±0.460	61.40±2.446	58.00±1.540
	90	87.26±3.476	87.54±0.556	90.12±0.364	87.15±0.453	72.96±0.295	71.70±2.856
	120	102.35±0.413	102.68±0.533	103.25±0.656	102.42±1.596	91.06±0.579	88.06±0.356
PBW 373	30	28.75±0.182	28.88±0.450	29.87±0.155	28.50±0.757	22.41±0.117	18.88±0.120
	60	72.34±0.376	72.42±1.923	73.90±1.152	71.98±2.868	61.26±0.955	57.84±0.301
	90	87.22±1.360	87.44±3.483	88.48±2.350	86.75±0.350	72.44±1.932	71.58±1.116

	120	102.28±2.716	102.55±0.415	102.87±4.098	102.26±0.650	90.87±3.620	87.92±2.335
UP 2338	30	28.67±1.142	28.82±0.183	29.52±0.120	28.25±0.147	22.20±0.089	18.65±0.743
	60	72.29±0.292	72.38±0.376	73.58±0.467	71.52±1.115	67.70±0.430	61.12±0.247
	90	87.15±0.554	87.35±1.361	88.23±0.458	86.48±2.297	72.60±0.377	71.45±0.454
	120	102.17±0.531	102.48±2.722	102.65±1.616	102.00±4.063	90.71±1.414	87.74±0.456
$N_{50}P_{40}K_{20}$							
Cultivar	Days	T_0	T_1	T_2	T_3	T_4	T_5
PBW 343	30	26.00±0.405	26.98±1.075	29.12±0.773	30.00±0.121	25.00±0.664	22.00±0.343
	60	67.90±1.803	68.82±0.278	72.89±2.504	74.00±0.470	65.00±2.589	62.00±1.647
	90	84.08±3.350	85.40±0.542	87.76±0.355	88.68±0.461	80.00±0.323	76.00±3.028
	120	97.00±0.392	98.00±0.509	102.76±0.653	102.93±1.604	94.00±0.597	91.25±0.369
PBW 373	30	26.50±0.168	26.84±0.418	29.03±0.151	31.87±0.846	24.87±0.129	21.68±0.138
	60	67.55±0.351	68.34±1.815	72.82±1.135	74.89±2.983	64.89±1.012	61.82±0.321
	90	83.80±1.306	84.69±3.374	87.59±2.326	89.93±0.364	78.73±2.091	75.79±1.181
	120	96.65±2.567	97.36±0.393	101.80±4.055	102.86±0.653	93.90±3.741	91.00±2.417
UP 2338	30	26.30±1.048	26.56±0.169	28.94±0.117	31.74±0.165	24.62±0.099	21.48±0.856
	60	67.38±0.272	68.23±0.355	72.73±0.462	74.68±1.164	64.74±0.411	61.68±0.249
	90	83.50±0.530	84.28±1.314	87.54±0.455	89.80±2.385	78.73±0.409	75.56±0.480
	120	96.28±0.501	97.12±2.580	101.66±1.585	102.74±4.093	93.65±1.460	90.45±0.470

± = Standard error, CD at 5 % level.

Table 3. Effect of sewage water on 50 % flowering and days to maturity of *Triticum aestivum* L. with fertilizer dose at $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$

$N_{100}P_{80}K_{40}$

Treatment	PBW 343		PBW 373		UP 2338	
	Days to 50 % flowering	Days of maturity	Days to 50 % flowering	Days of maturity	Days to 50 % flowering	Days of maturity
T_0	67±1.044	104±2.762	67±2.669	104±0.420	67±0.425	104±0.540
T_1	66±2.629	103±0.416	66±0.419	104±0.540	67±1.044	104±2.762

T_2	65±1.726	102±4.063	65±0.263	103±0.654	66±0.343	103±1.606
T_3	70±0.283	108±0.686	71±0.369	109±1.699	71±1.886	109±4.342
T_4	73±1.939	111±4.422	73±0.295	112±0.711	74±0.384	112±1.746
T_5	74±1.154	111±2.948	74±2.948	112±0.453	75±0.476	113±0.587
$N_{50}P_{40}K_{20}$						
Treatment	PBW 343		PBW 373		UP 2338	
	Days to 50 % flowering	Days of maturity	Days to 50 % flowering	Days of maturity	Days to 50 % flowering	Days of maturity
T_0	69±1.076	105±2.739	69±2.749	105±0.424	70±0.445	105±0.545
T_1	67±2.669	106±0.428	68±0.432	106±0.551	68±1.060	107±2.842
T_2	66±1.753	107±4.263	66±0.267	107±0.679	67±0.348	108±1.584
T_3	64±0.259	100±0.635	64±0.332	101±1.574	65±1.726	101±4.024
T_4	72±1.912	109±4.342	72±0.291	111±0.705	72±0.374	111±1.730
T_5	73±1.138	110±2.921	72±2.868	110±0.445	72±0.457	110±0.572

± = Standard error, CD at 5 % level.

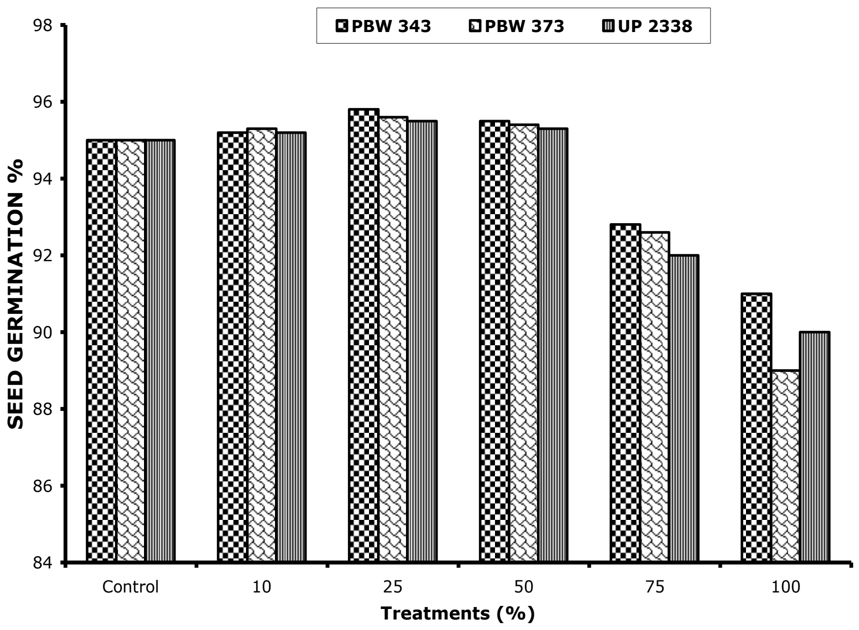

Fig. 1 (a): Seed germination percentage of three cultivars of *Triticum aestivum* L. treated with different concentration of sewage water at $N_{100}P_{80}K_{40}$.

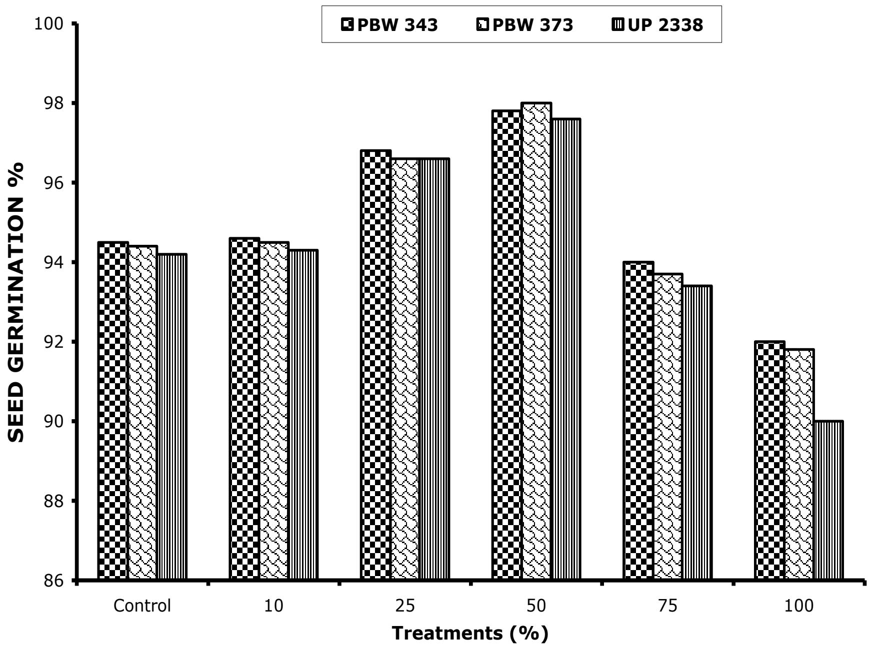

Fig. 1 (b) : Seed germination percentage of three cultivars of *Triticum aestivum* L. treated with different concentration of sewage water at $N_{50}P_{40}K_{20}$.

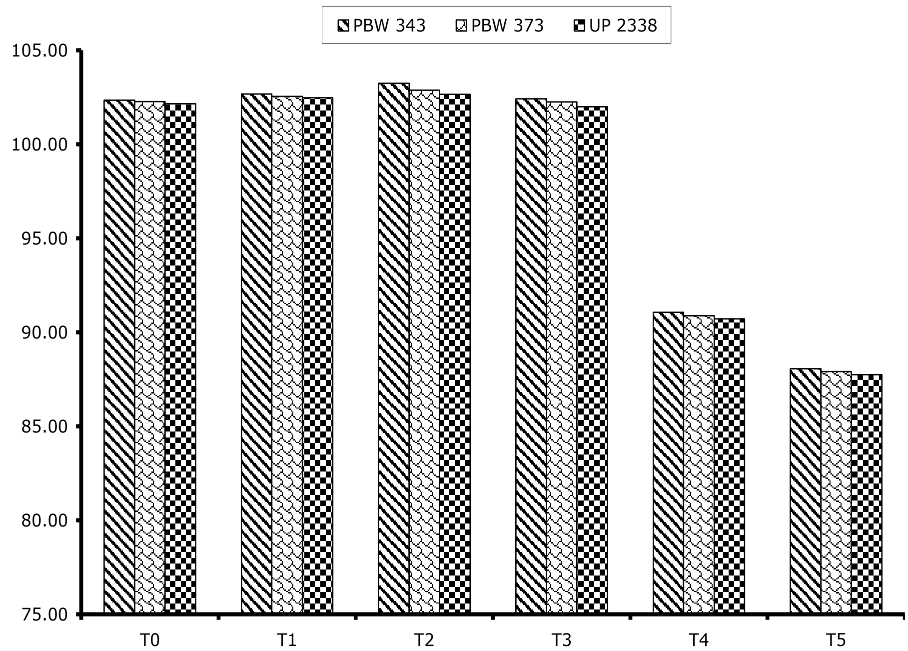

Fig. 2 (a) : Effect of sewage water on plant height (cm) of *Triticum aestivum* L. at 120 DAS with fertilizer dose at $N_{100}P_{80}K_{40.}$

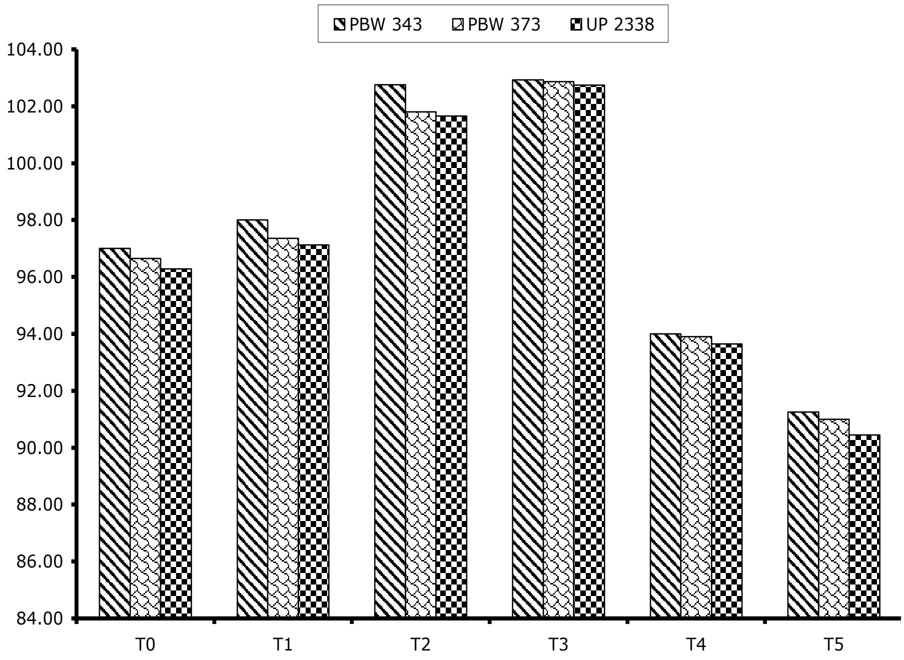

Fig. 2 (b) : Effect of sewage water on plant height (cm) of *Triticum aestivum* L. at 120 DAS with fertilizer dose at $N_{50}P_{40}K_{20}$.

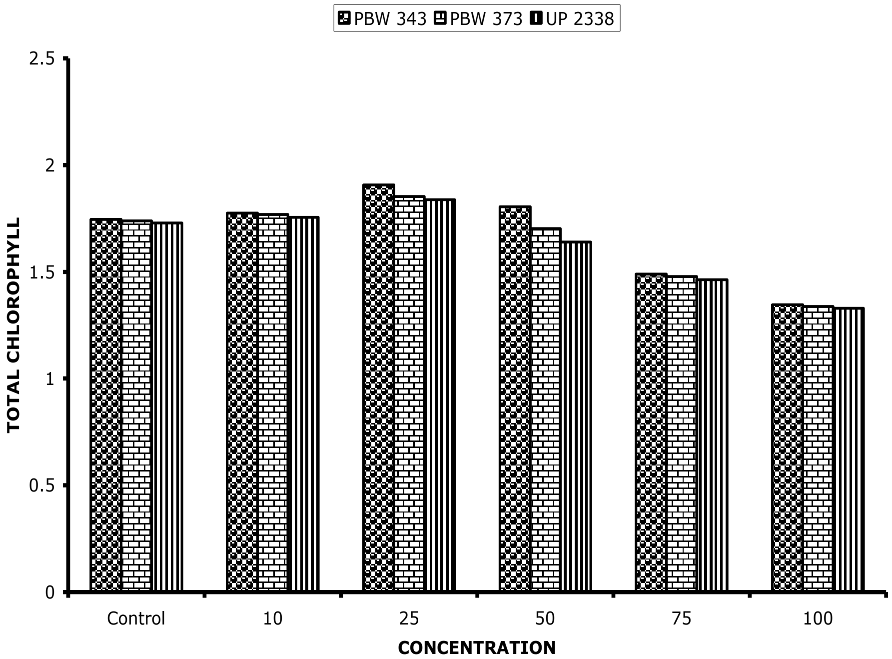

Fig. 3 (a) : Effect of sewage water on total chlorophyll contents of three cultivars of *Triticum aestivum* L. at $N_{100}P_{80}K_{40}$.

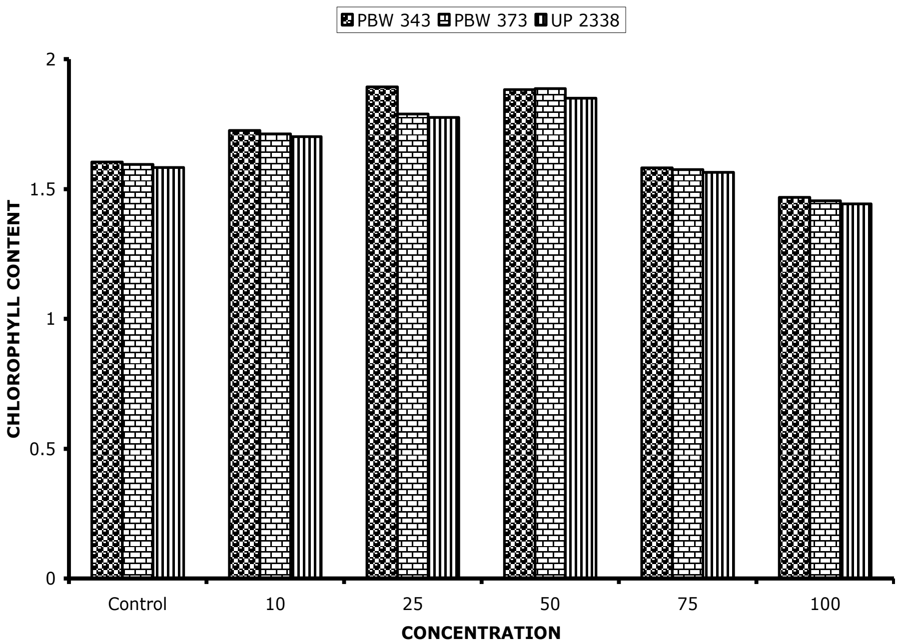

Fig. 3 (b) : Effect of sewage water on total chlorophyll contents of three cultivars of *Triticum aestivum* L. at $N_{50}P_{40}K_{20}$.

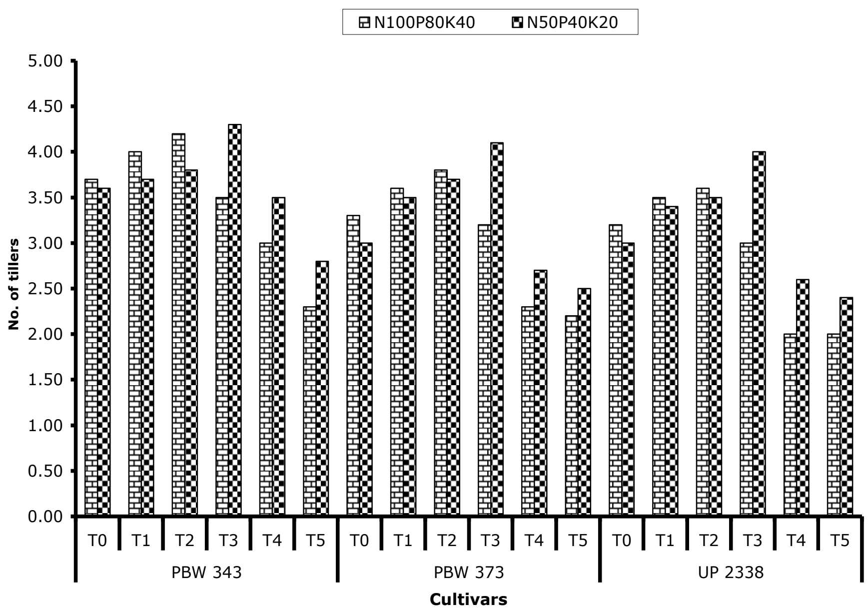

Fig. 4 : Effect of sewage water on number of tillers of *Triticum aestivum* L. with fertilizer dose at $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$.

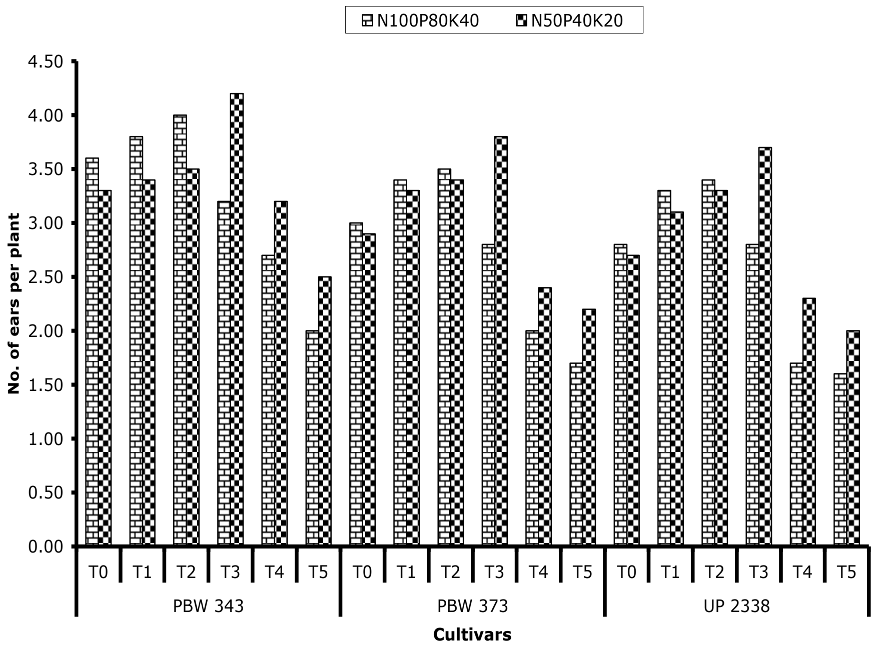

Fig. 5 : Effect of sewage water on number of ears of *Triticum aestivum* L. with fertilizer dose at $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$.

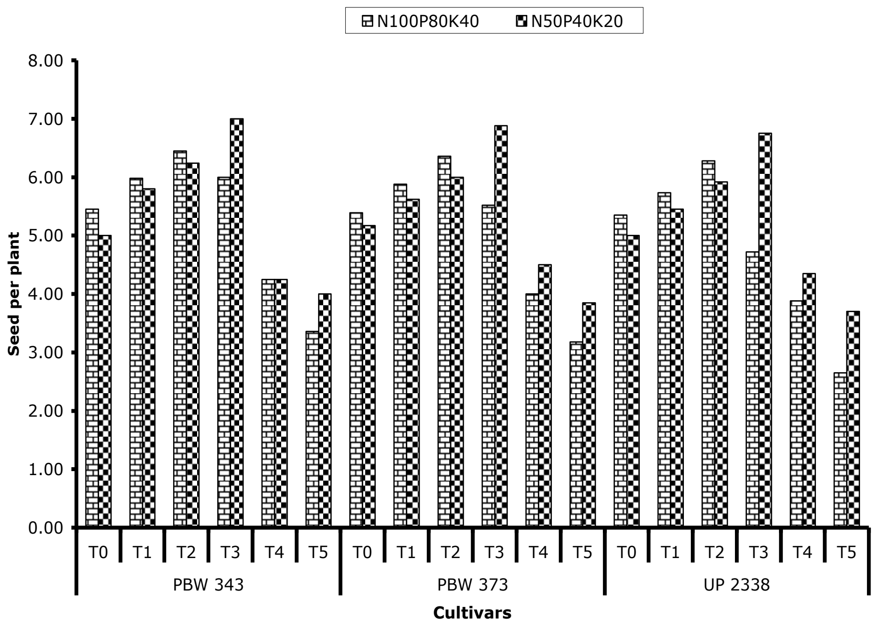

Fig. 6 : Effect of sewage water on seed per plant of *Triticum aestivum* L. with fertilizer dose at $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$.

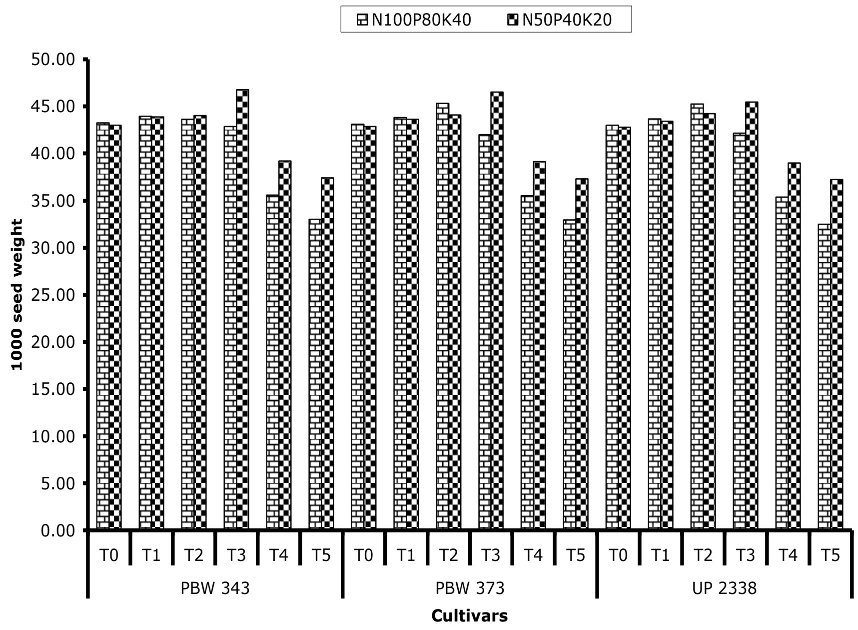

Fig. 7 : Effect of sewage water on 1000 seeds weight of *Triticum aestivum* L. in with fertilizer dose at $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$.

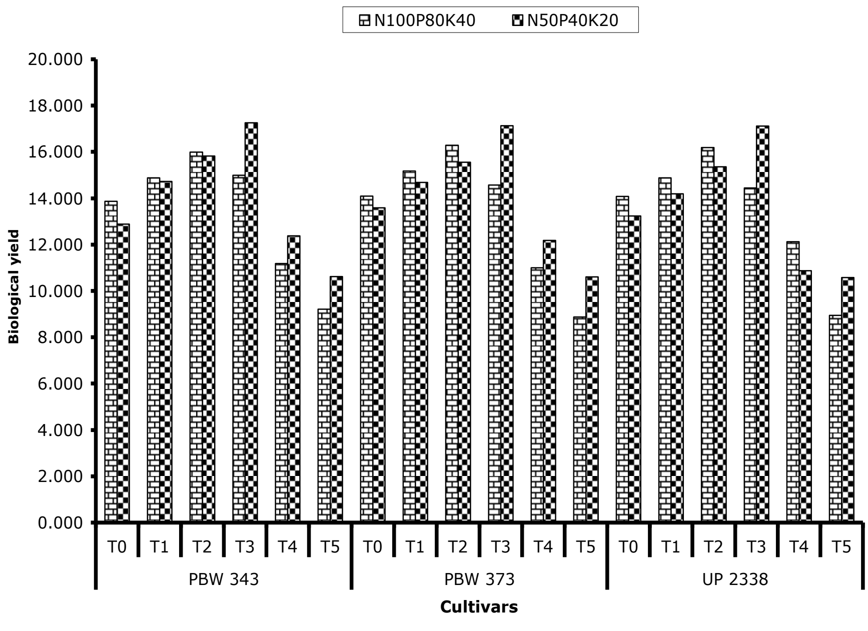

Fig. 8 : Effect of sewage water on biological yield of *Triticum aestivum* L. with fertilizer dose at $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$.

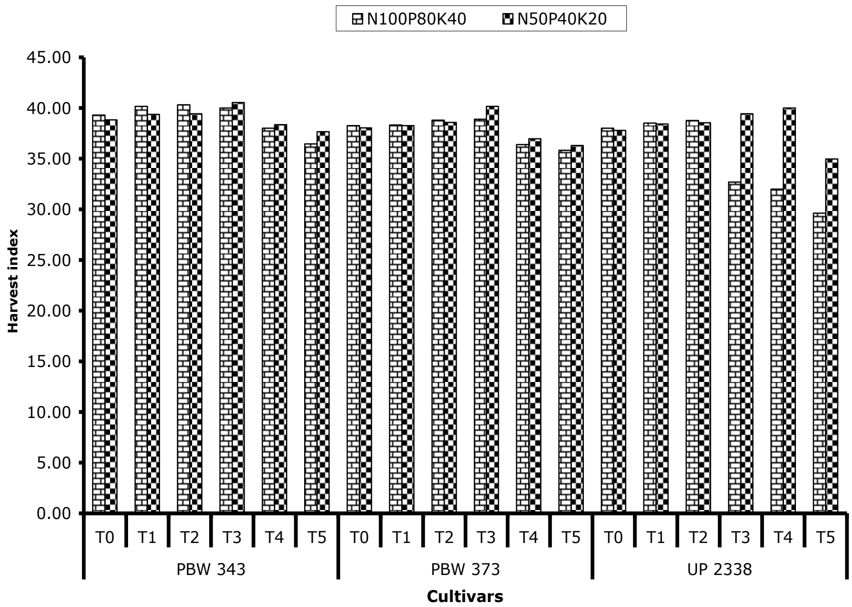

Fig. 9 : Effect of sewage water on harvest index. of *Triticum aestivum* L. with fertilizer dose at $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$.

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