RESPONSE OF WHEAT TO THERMAL POWER PLANT DISCHARGED WASTEWATER (TPPW) SUPPLEMENTED WITH NPK FERTILIZER

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Abstract : A pot experiment was conducted in the winter season of 2008-2009 to evaluate the suitability of Thermal Power Plant discharged Wastewater of National Thermal Power Corporation (NTPC), Dadri as a source of irrigation and its impact on growth and yield components of two wheat cultivars *viz.* PBW 343 and UP 2338. The test crop was raised with different concentration of TPPW (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 supplemented with fertilizer $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$. TPPW with $N_{100}P_{80}K_{40}$ promoted growth, number of tillers, number of ears, total chlorophyll, seed yield per plant, 1000 seed weight, biological yield and harvest index as compared to control. 75 % effluent was found most suitable for the measured growth and yield parameters while 100 % concentration proved inhibitory. TPPW may be considered as an alternative of fresh water for irrigation purpose improving yield and quality of wheat crop.

Keywords: TPPW, Germination, Chlorophyll content, Growth yield

INTRODUCTION

Water related problems are increasingly recognized as one of the most immediate and serious environmental threats to human kind. Water use has more than tripled globally since 1950, and one out of every six person does not have regular access to safe drinking water. The latest global environmental outlook of the United Nations Environmental Programme (UNEP) reports that about one third of the World's population currently live in countries suffering from moderate to high water stress where water consumption is more than 10 % of renewable fresh water resources. However, the habitable land areas have only limited fresh water resources and only about 0.5 % is present either as ground water or as surface water in lakes, rivers, ponds, dams etc. (Cunningham and Saigo, 1995). Industrial effluents are constantly adding up toxic substances into the ground water reservoir at a very high rate, especially in industrial zone. Many regions all over the globe are heavily depending on ground water for various purposes (Babiker *et al.*, 2004; Nair *et al.,* 2006). Contrarily enormous amount of wastewater is generated every year from urban population and industrialization and may cause environmental threat worldwide including India. Therefore, planned collection, treatment and disposal of the Wastewater are an important component in the protection of public health, surface soil and fresh water. The industrial effluent contain large mount of nutrients as well as toxic elements (Nath *et al.,* 2009) that enhance growth and yield of crop plants (Shah *et al.,* 2004; Gupta *et al.,* 2005; Javid *et al.,* 2006). TPPW seems to have evaded the attention of researchers especially in India. This needs serious consideration as 85 such power plants are generating million litres of Wastewater. The utility of municipal and industrial Wastewater for irrigation of crops is well documented (Aziz *et al.,* 1999; Akhtar *et al.,* 2006; Javid *et al.,* 2006, Singh *et al.,* 2006, Nath *et al.,* 2007). The present study was conducted to assess the feasibility of exploring the use of effluents generated by thermal power plant located at Dadri, district Gautam Buddha Nagar of western Uttar Pradesh for cultivation of wheat crop.

MATERIALS AND METHODS

Experimental site

Present experiment was conducted in the Department of Botany, Kisan (P.G.) College, Simbhaoli (Ghaziabad) during 2008-2009 growth seasons. 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 two wheat cultivars PBW 343 and UP 2338 were obtained from National Seed Corporation, Meerut.

Source of wastewater

Wastewater was collected from the outlet of NTPC (National Thermal Power Corporation), Dadri, Gautam Buddha Nagar (U.P.). This effluent was collected only 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 effluent collected from Thermal Power Plant was analyzed for various parameters of water quality according to Standard Procedure (APHA *et al.,* 2005).

Experiment design

Thick polythene bags (25 cm dia) 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 effluents treatment *viz.* T_0 (normal ground water or control), TPPW concentration (T_1: 10 %, T_2: 25 %, T_3: 50 %, T_4: 75 %, T_5: 100 % non diluted effluent) used for the experiment. 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 in 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 effluent 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 of 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.

RESULTS AND DISCUSSION

Thermal power Wastewater was alkaline with moderate electrical conductivity (Table 1). Amount of total solids (TDS) and concentration of some inorganic essential ions was higher in TPPW than GW (ground water) , of these nitrate, NH_3, nitrogen, phosphate, sulphates, calcium, magnesium and potassium could be considered beneficial as these are essential for plants. It may be pointed out that high concentration of sodium and chloride are known to cause specific ion toxicity to plants, however, sodium upto 70 mg/l^{-1} does not cause any problem and in the present study the measured concentration was well below this range. Similarly, concentration of chloride in the range of 140-350 mg/l^{-1} may cause slight to moderate problems for the growth of plants but had the values even below the lower range (Table 1). However, total hardness was higher than control water. Alkalinity of the effluents seems to be due to bicarbonates and carbonates. Low amount of dissolved oxygen was observed in the effluent. In addition, pH was also within the range is very important for nutrient availability. The soil was sandy loam in texture with pH below 7 and good CEC. Nutrients availability and proper root growth is dependent on pH, which should be between 6.5-8.3. TPPW was well below the toxic limits prescribed by the Bureau of Indian Standards. Therefore, Wastewater falls within the safe category. Electrical conductivity (E.C.) is directly related to the sum of the cations or anions and is closely correlated in general with the total salt concentration. EC value between 468-1200 μmhos cm^{-1} in Wastewater is permissible for irrigation purposes.

The TPPW application proved better than GW for all growth characteristics studies sowing higher value for germination percentage, plant height, chlorophyll content, number of tillers, days to 50 % flowering (Table 3), number of ears, days to maturity (Table 3), seed per plant, 1000 seed weight, biological yield and harvest index.

Seed germination percentage was observed maximum in 75 % concentration of TPPW with $N_{100}P_{80}K_{40}$ fertilizer level in both the cultivars (Figs. 1a & b). Plant height has been revealed slightly promotary in 75 % of TPPW under fertilizer level $N_{100}P_{80}K_{40}$ and inhibitory in non diluted TPPW (Table 2, Fig. 2). Our findings are in agreement with that of (Akhtar *et al.,* 2006; Javid *et al.,* 2006). The effluent of higher concentration (75 %) of Wastewater has been manifested in the form of higher chlorophyll content (Fig. 3) and so TPPW favour the development of photosynthetic pigment (Javid *et al.,* 2006; Akhtar *et al.,* 2008).

Yield is the final manifestation of physiological, morphological and biological trait of a crop. The availability of essential nutrients in the TPPW as well as in soil supplied and the ready acquisition by the growing plant lead to formation of more reproductive parts which commulatively are responsible for higher seed yield. The beneficial effect of TPPW on growth and yield parameter may be possible due to the presence and regular supply of essential and beneficial nutrients present in TPPW. The present data also confirm the earlier findings while applying industrial Wastewater on different crops (Aziz *et al.,* 1999; Hayat *et al.,* 2000; Malaviya and Sharma, 2011).

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 results corroborate the findings of Medhi *et al.* (2011) who found increased growth and yield of agriculture crop : rice, mustard and pea. Singh *et al.,* 2006 and 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). Harvest index frequently do not provide satisfactory measure of plant yield efficiency but seed yield merit always provides a clear picture of photosynthate partitioning (Imsande, 1992).

Yield parameters like 1000 seed weight, biological and harvest index register the higher values in 75 % of TPPW under the fertilizer level $N_{100}P_{80}K_{40}$. Similar results have been recorded by Darwish *et al.* (1999), Sourmare *et al.* (2003), Shah *et al.* (2004), Gupta *et al.* (2005), Javid *et al.* (2006) and Tabassum *et al.* (2007). Data of soil analysis (irrigated with TPPW) were recorded after harvesting the crop. For Wastewater discharged by many industrial units, the general belief is that continuous irrigation with such Wastewater may deteriorate the quality of soil by reducing infiltration rate and pore space which directly effect 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 TPPW. Thus it may be concluded that the soil did not retain excessive amount of salts during the experimental period. TPPW may be considered as an alternative of fresh water for irrigation purpose in improving yield and quality of wheat crop.

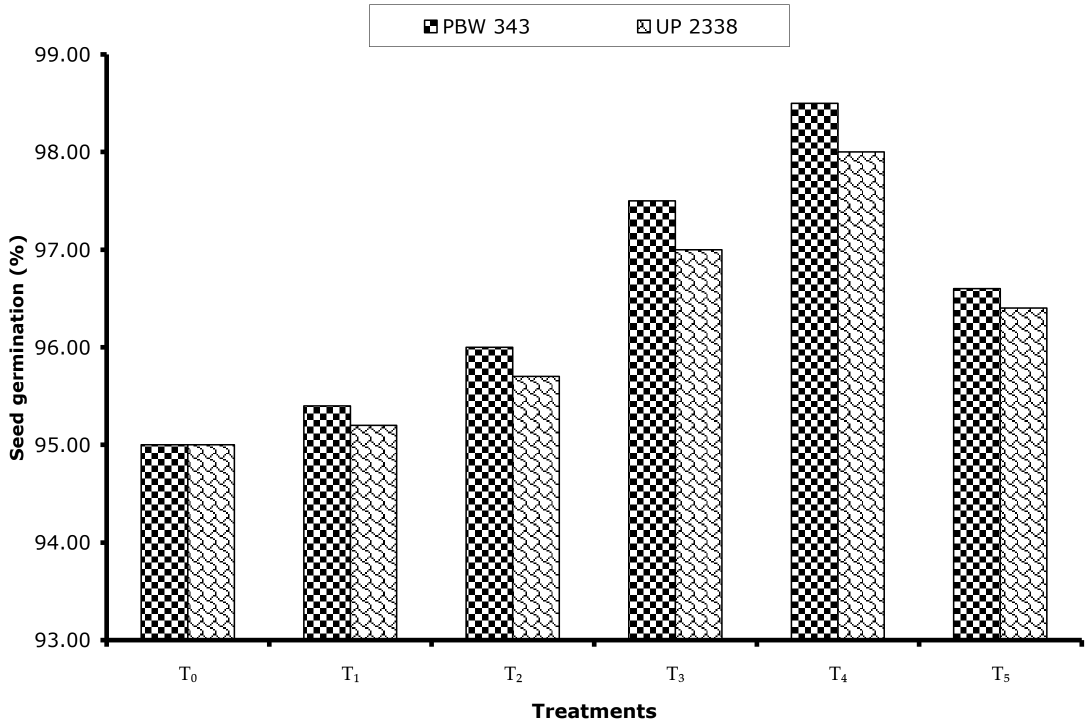

Fig. 1 (a): Seed germination percentage of two cultivars of *Triticum aestivum* L. treated with different concentration of thermal power plant waste water at $N_{100}P_{80}K_{40}$.

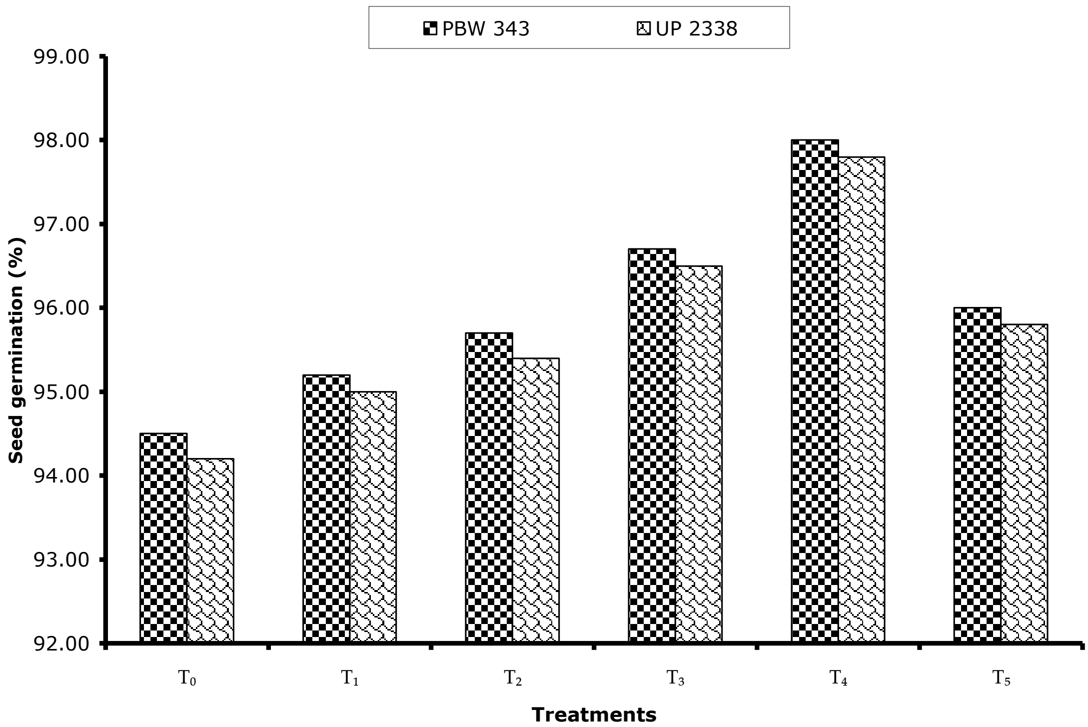

Fig. 1 (b): Seed germination percentage of two cultivars of *Triticum aestivum* L. treated with different concentration of thermal power plant waste water at $N_{50}P_{40}K_{20}$.

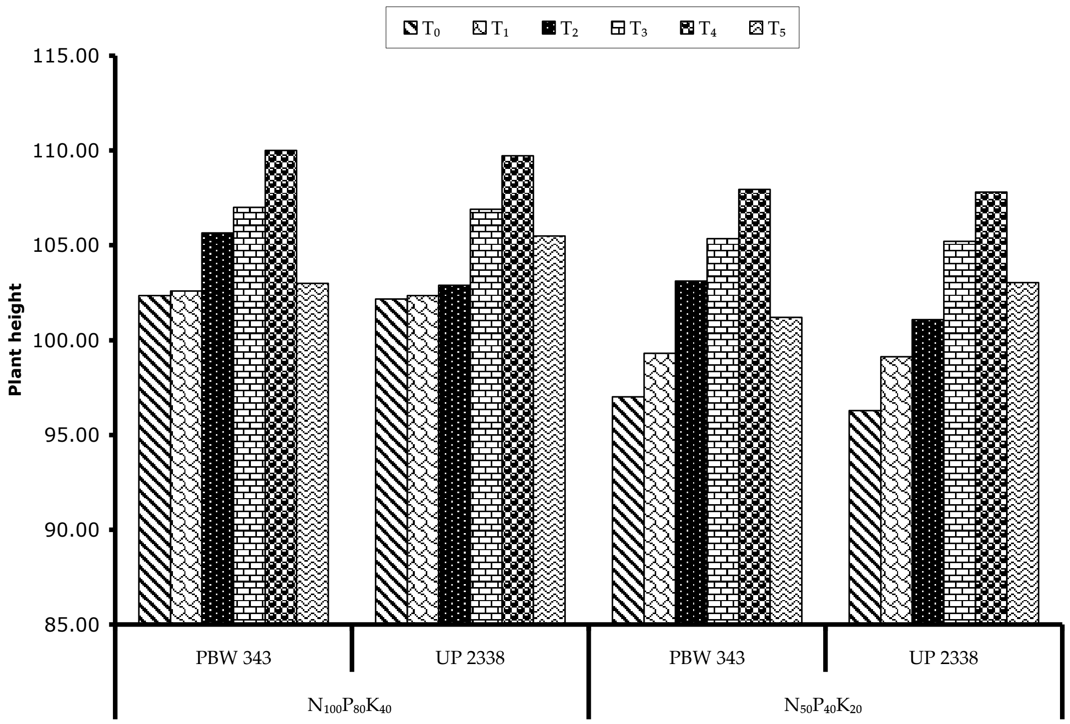

Fig. 2: Plant height of two cultivars of *Triticum aestivum* L. at 120 days treated with different concentration of thermal power plant waste water at $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$.

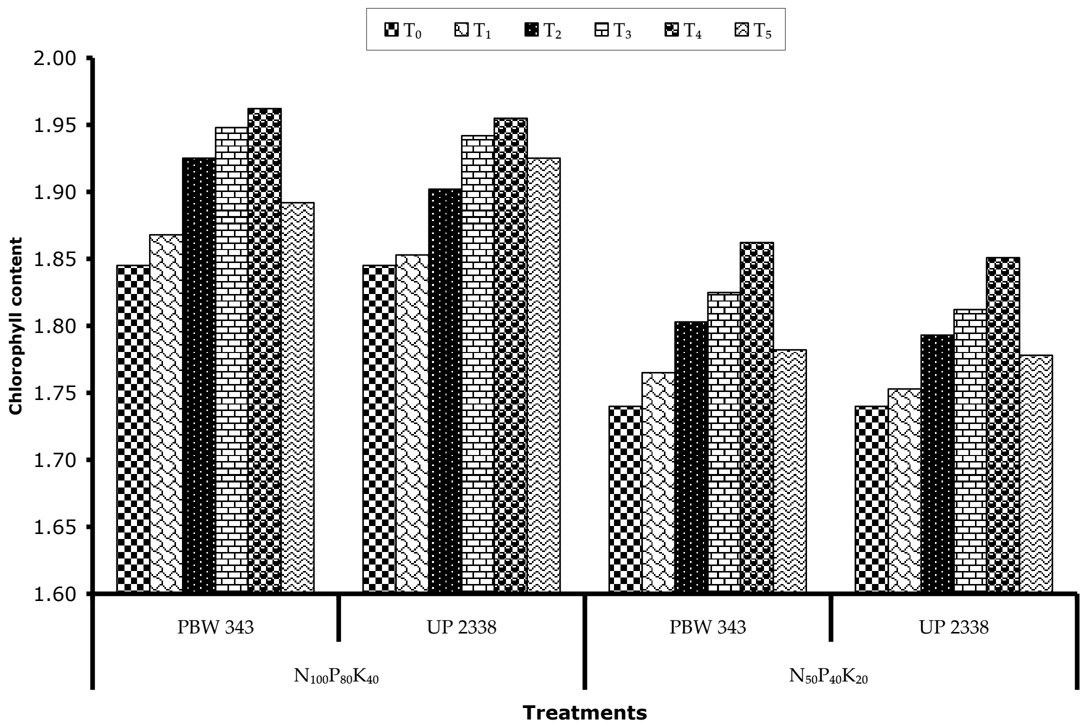

Fig. 3: Chlorophyll contents of two cultivars of *Triticum aestivum* L. treated with different concentration of thermal power plant waste water at $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$.

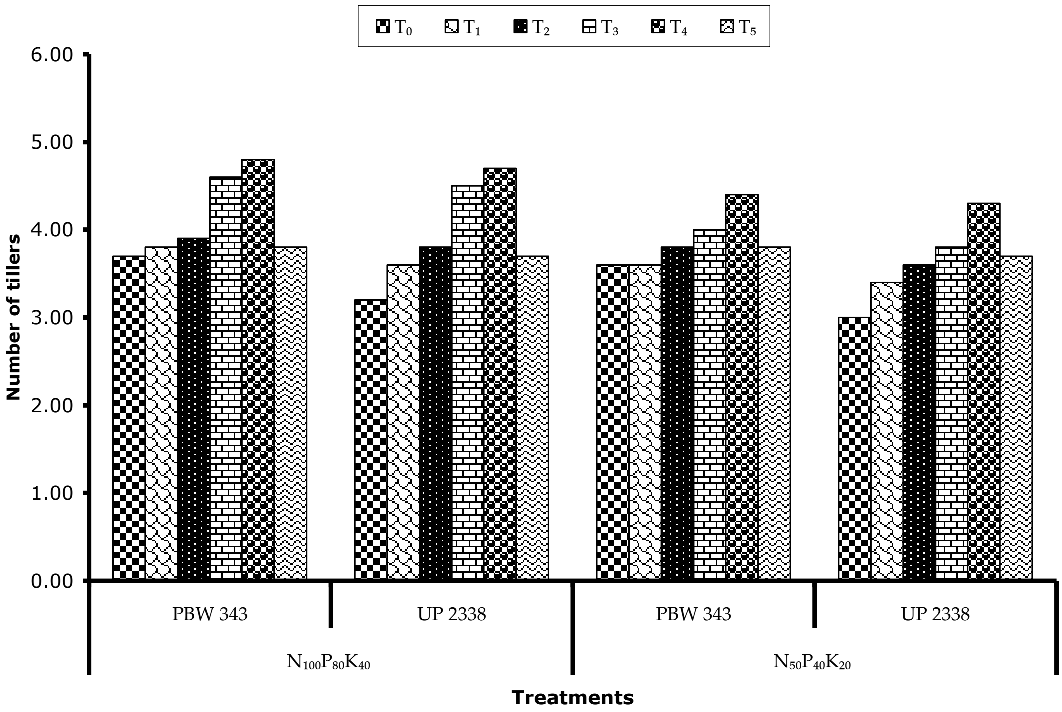

Fig. 4: Number of tillers of two cultivars of *Triticum aestivum* L. at 120 days treated with different concentration of thermal power plant waste water at $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$.

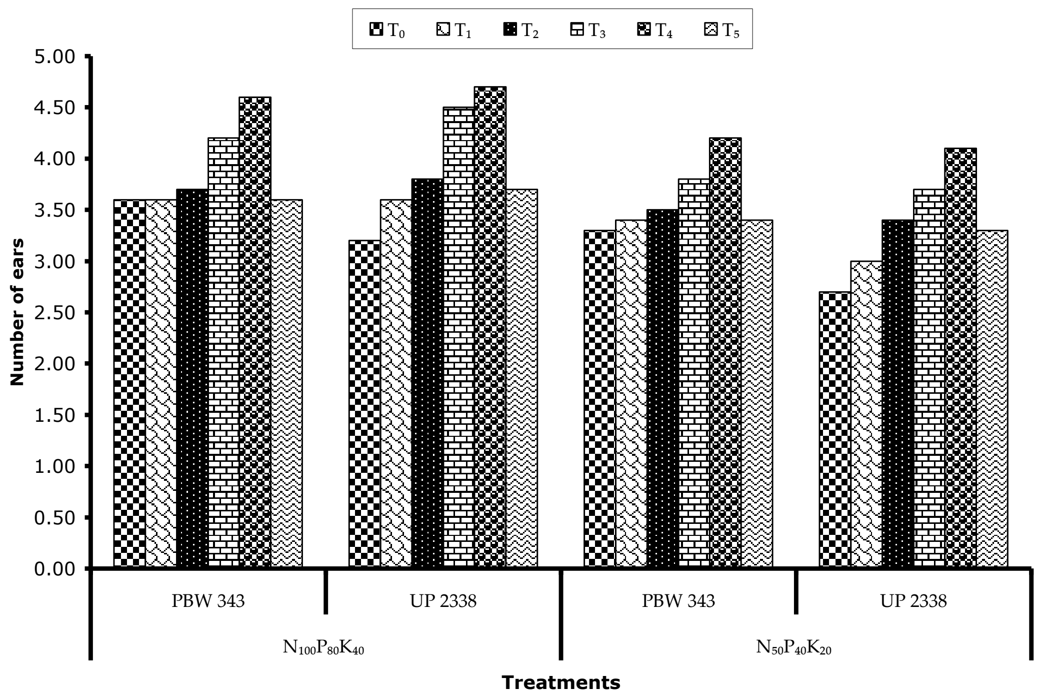

Fig. 5: Number of ears of two cultivars of *Triticum aestivum* L. treated with different concentration of thermal power plant waste water at $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$.

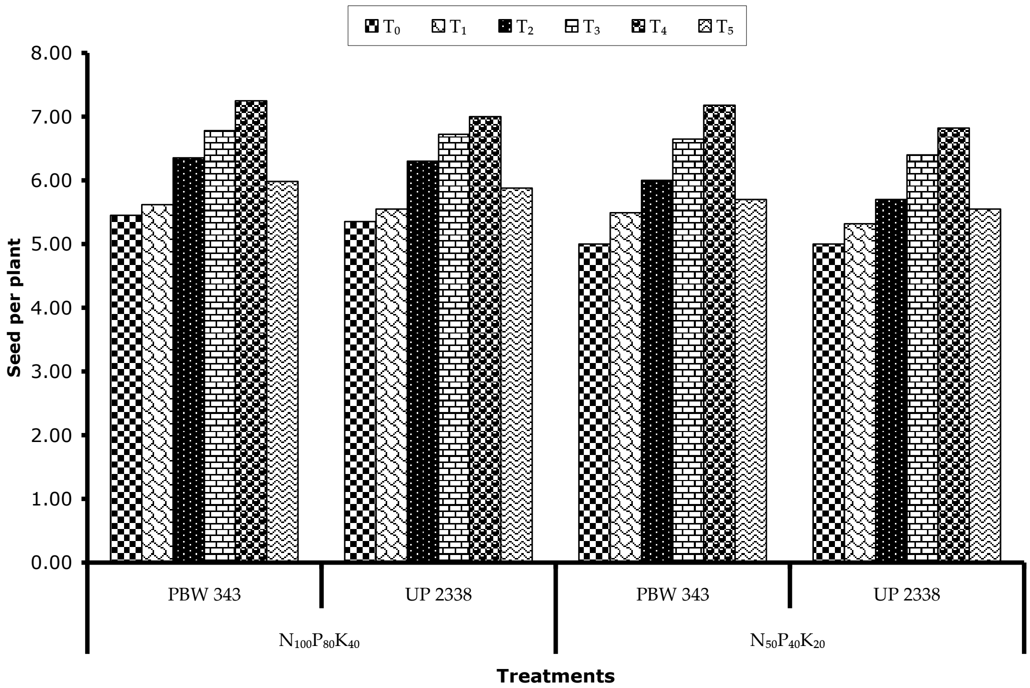

Fig. 6: Weight of seed per plant of two cultivars of *Triticum aestivum* L. at 120 days treated with different concentration of thermal power plant waste water at $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$.

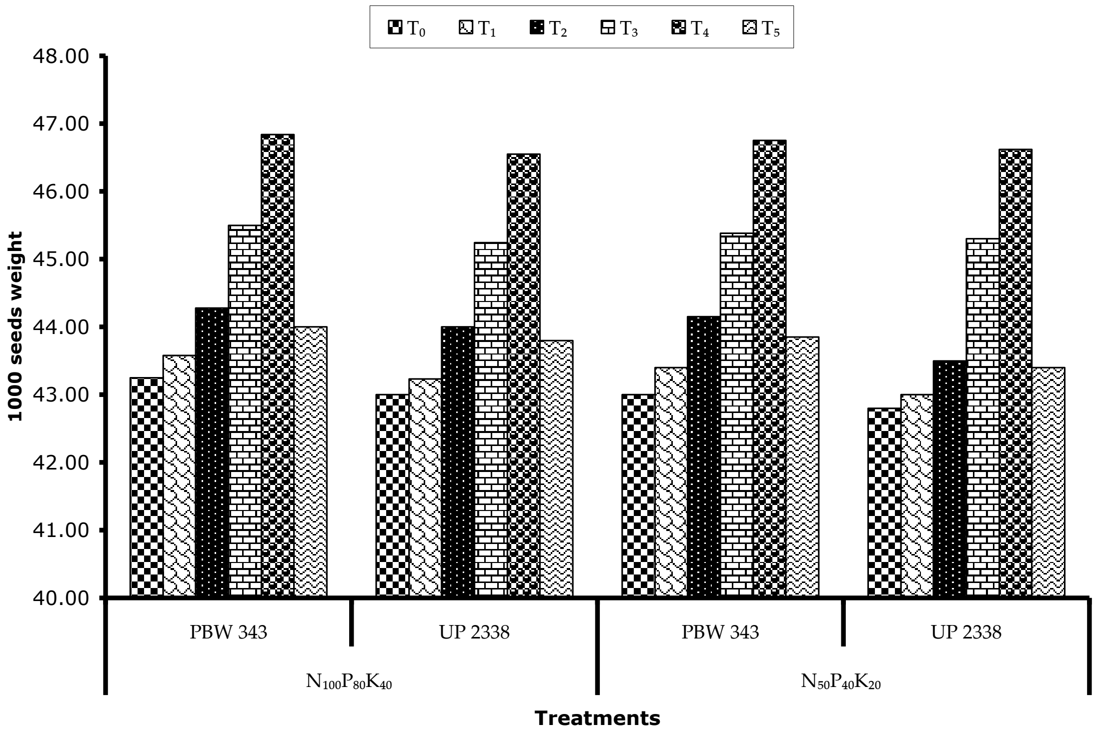

Fig. 7: 1000 seeds weight of two cultivars of *Triticum aestivum* L. treated with different concentration of thermal power plant waste water at $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$.

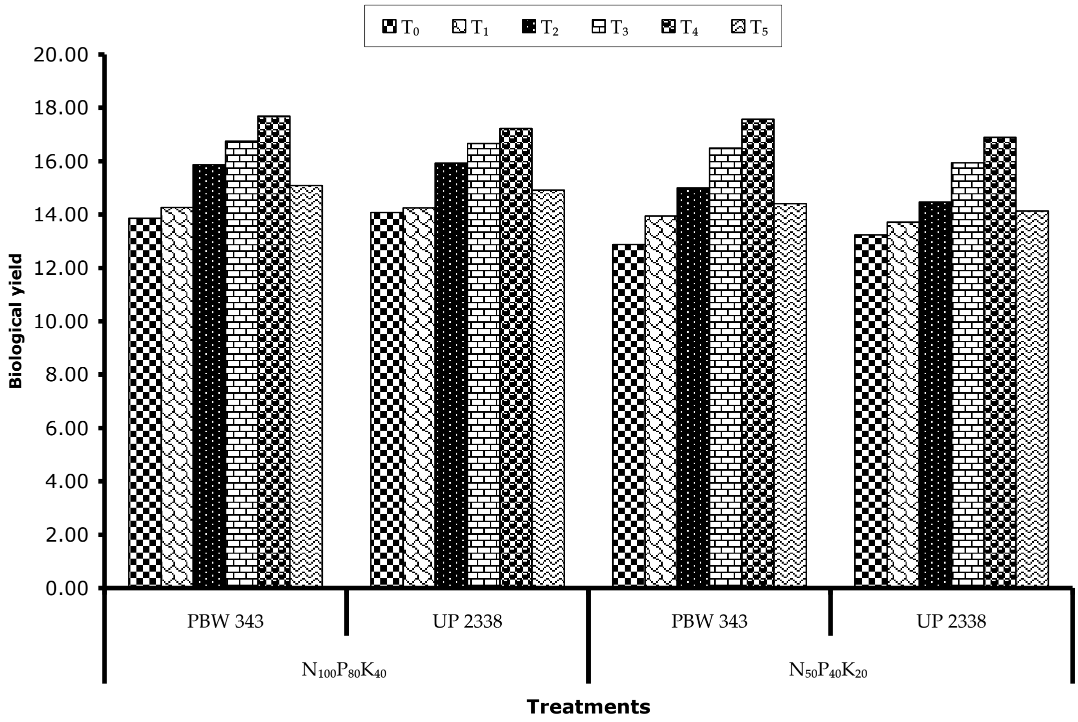

Fig. 8: Biological yield of two cultivars of *Triticum aestivum* L. at 120 days treated with different concentration of thermal power plant waste water at $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$.

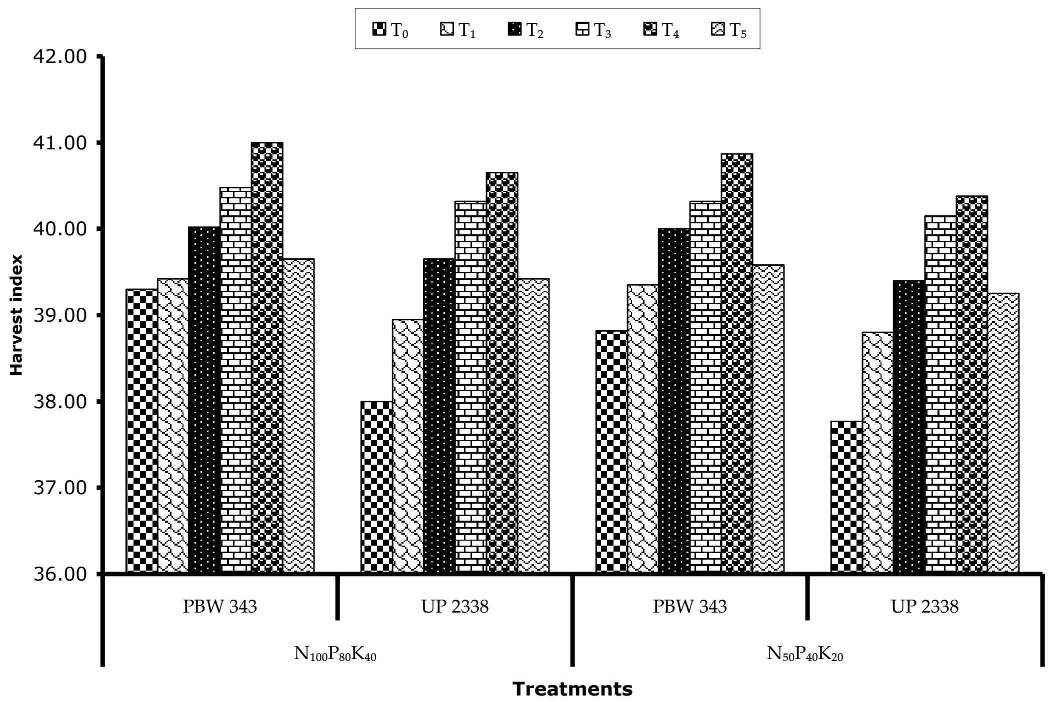

Fig. 9: Harvest index of two cultivars of *Triticum aestivum* L. treated with different concentration of thermal power plant waste water at $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$.

Table 1: Physicochemical Characteristics of Thermal Power Plant wastewater and ground water **.**

Sl.	Parameters	Sewage Water	Ground Water
1	pH	7.78	7.5
2	Hardness	180 ppm	220 ppm
3	TDS	645 mg^{-1}	468 mg^{-1}
4	TSS	714 mg^{-1}	325 mg^{-1}
5	COD	127.38 mg^{-1}	37.35 mg^{-1}
6	BOD	64.46 mg^{-1}	15.85 mg^{-1}
7	Temperature	15.3^{0}C	15.0^{0}C
8	Colour	Slight blackish	Colourless
9	Odour	Unpleasant	Odourless
10	E.C. (Electrical conductivity)	892 □mhos cm^{-1}	615 □mhos cm^{-1}
11	DO	2.7 mg^{-1}	2.3 mg^{-1}
12	Ca	40.06 mg^{-1}	25.72 mg^{-1}
13	K	17.25 mg^{-1}	7.26 mg^{-1}
14	Na	45.52 mg^{-1}	15.3 mg^{-1}
15	Cl	108.52 mg^{-1}	69.83 mg^{-1}
16	CO_3	38.54 mg^{-1}	20 mg^{-1}
17	PO_4	1.48 mg^{-1}	Nil
18	Mg	30.12 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 Thermal Power Plant wastewater (TPPW) on 50 % flowering and days to maturity of *Triticum aestivum* L. with fertilizer dose at $N_{100}P_{80}K_{40}$ and $N_{50}P_{40}K_{20}$

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

Cultivar	Days	T_0	T_1	T_2	T_3	T_4	T_5
PBW 343	Days to 50 % flowering	67±0.425	66±1.029	65±0.338	63±1.673	62±0.322	66±0.419
	Days to maturity	104±0.540	104±2.762	103±1.606	102±4.063	100±1.559	103±0.535
UP 2338	Days to 50 % flowering	67±1.044	66±2.629	64±1.700	64±0.259	63±1.673	65±1.013
	Days to maturity	104±2.762	104±0.420	103±4.103	102±0.648	102±4.063	104±2.762
$N_{50}P_{40}K_{20}$							
Cultivar	Days	T_0	T_1	T_2	T_3	T_4	T_5
PBW 343	Days to 50 % flowering	69±2.749	68±0.432	66±0.267	65±0.338	63±0.255	67±2.669
	Days to maturity	105±0.424	104±0.540	103±0.654	102±1.590	102±0.648	104±0.420

UP 2338	Days to 50 % flowering	70±0.445	69±1.076	67±0.348	66±1.753	65±0.338	68±0.432
	Days to maturity	105±0.545	104±2.762	104±1.621	103±4.103	103±1.606	104±0.540

ACKNOWLEDGEMENT

The authors are grateful to Dr. Maya Rani, Principal, Kisan (P.G.) College, Simbhaoli (Ghaziabad) U.P. for providing necessary facilities for the present research work. We are also thankful to Thermal Power Plant, Dadri for supplying TPPW.

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